FINAL STATUS SURVEY REPORT (FSSR)
PARCEL A, PARCEL LOWER C, AND PARCEL UPPER C

Li Tungsten Site
83 Herb Hill Road
Glen Cove, New York 11542

CERCLIS ID: NYD986882660
NYS Site Code: 130046

Rev. 1

April 2015

Prepared for:
RXR Glen Isle Partners, LLC
625 RXR Plaza
Uniondale, NY 11556

Prepared by:
Safety and Ecology Corporation (SEC)
2800 Solway Road
Knoxville, TN 37931

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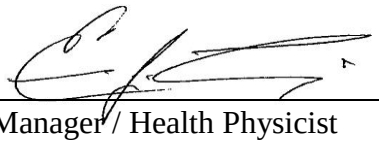
FSSP APPROVALS

PREPARED BY:



4/6/15

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4/6/15

Corporate Certified Health Physicist — Date
Andrew Lombardo, CHP

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ARS	American Radiation Services
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cm	centimeter
CoC	Chain of Custody
cpm	counts per minute
DCGL	Derived Concentration Guideline Level
EMC	Elevated Measurement Comparison
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FSS	Final Status Survey
FSSP	Final Status Survey Plan
FSSR	Final Status Survey Report
g	gram
GPS	Global Positioning System
GWS	Gamma Walkover Survey
HP	Health Physicist
HSA	Historical Site Assessment
LA	Louisiana
LBGR	Lower Bound of Gray Region
m	meter
m^2	square meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
NaI	Sodium Iodide
NELAP	National Environmental Laboratory Accreditation Program
No.	Number
NPL	National Priorities List
NUREG	U.S. Nuclear Regulatory Commission Regulation
NY	New York
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
pCi	picoCuries
PWG	P.W. Grosser, Inc.

QA	Quality Assurance
QC	Quality Control
Ra-226	Radium-226
Ra-228	Radium-228
RCOC	Radiological Contaminant of Concern
ROD	Record of Decision
SEC	Safety and Ecology Corporation
Th-230	Thorium-230
Th-232	Thorium-232
U.S.	United States
WRS	Wilcoxon Rank Sum

EXECUTIVE SUMMARY

Safety and Ecology Corporation (SEC) was contracted to evaluate Li Tungsten data gap concerns raised by the New York State (NYS) Department of Health and the NYS Department of Environmental Conservation. Once data gaps were confirmed through a historical site assessment, SEC proceeded to address the data gaps by performing additional Final Status Survey (FSS) data collection.

The Site is identified on the *National Priorities List* (NPL) as "Li Tungsten Corp." with the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number NYD986882660. The Site is also listed as a Class 2 Inactive Hazardous Waste Site, identified as "Li Tungsten" within the NY State Superfund Program, with Site Code number 130046.

The applicable cleanup criteria for the Site were established in the 2005 ESD (EPA 2005). The 2005 criteria modified the 1999 ROD criteria (EPA 1999) by including an additional radium isotope [radium-228 (Ra-228)] and an additional thorium isotope [thorium-230 (Th-230)] to the original radium-226 (Ra-226) and thorium-232 (Th-232) radiological contaminants of concern (RCOCs). The 2005 ESD criteria consist of the following:

- Ra-226 combined with Ra-228: Less than 5 picoCuries/gram (pCi/g) above background.
- Th-230 combined with Th-232: Less than 5 pCi/g above background.

In order to resolve the identified data gaps, SEC divided the areas of concern into six Class 2 areas in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (EPA, 2000).

The methodology for collecting FSS measurements was derived from the MARSSIM-based approach as outlined in the *Li Tungsten Final Status Survey Plan* (SEC, 2014). The FSS survey consisted of:

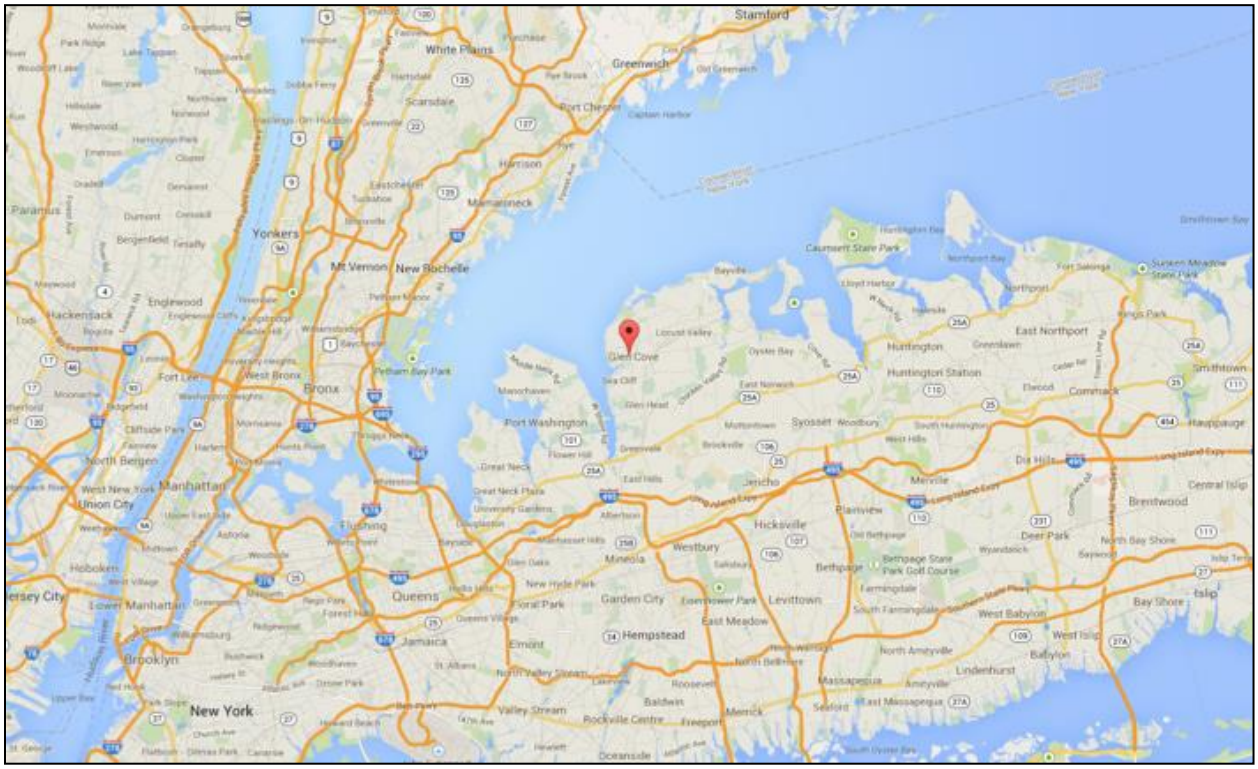
- Performance of a gamma walkover survey (GWS) over 100% of accessible areas.
- Collection and analysis of systematic surface soil samples to a depth of 6 inches.
- Collection and analysis of judgmental or "biased" soil samples to a depth of 6 inches.

The FSS data evaluation presented in this report demonstrates that data gaps have been adequately addressed and that the final radiological status of Parcel A, Parcel Lower C, and Parcel Upper C satisfies the requirement for unrestricted use without radiological restrictions and that no further radiological monitoring should be required at the Li Tungsten Site.

1.0 INTRODUCTION

This report delivers the results of the FSS performed by Safety and Ecology Corporation (SEC) at the historic Li Tungsten Superfund Site (Site) located at 83 Herb Hill Road, Glen Cove, New York (NY), roughly 25 miles east-northeast of New York City (**Figure 1-1**). The survey was performed between August and December, 2014. The objective of the FSS was to acquire data of sufficient quality and quantity to demonstrate that the soil concentrations within the surveyed areas are below the Site clean-up criteria thereby releasing the Site from radiological restrictions or controls. This report pertains specifically to Parcel A, Parcel Lower C, and Parcel Upper C only, and includes six survey units. The FSS for other parcels and Operating Unit II of the Superfund Site were reviewed to determine their validity and were deemed to have been closed out according to MARSSIM procedures. Only the parcels herein were deemed to need additional investigation to achieve industry closeout standards.

Figure 1-1. Li Tungsten Site Location



The Site is identified on the *National Priorities List* (NPL) as "Li Tungsten Corp." with the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number NYD986882660. The Site is also listed as a Class 2 Inactive Hazardous Waste Site, identified as "Li Tungsten" within the NY State Superfund Program, with Site Code number 130046.

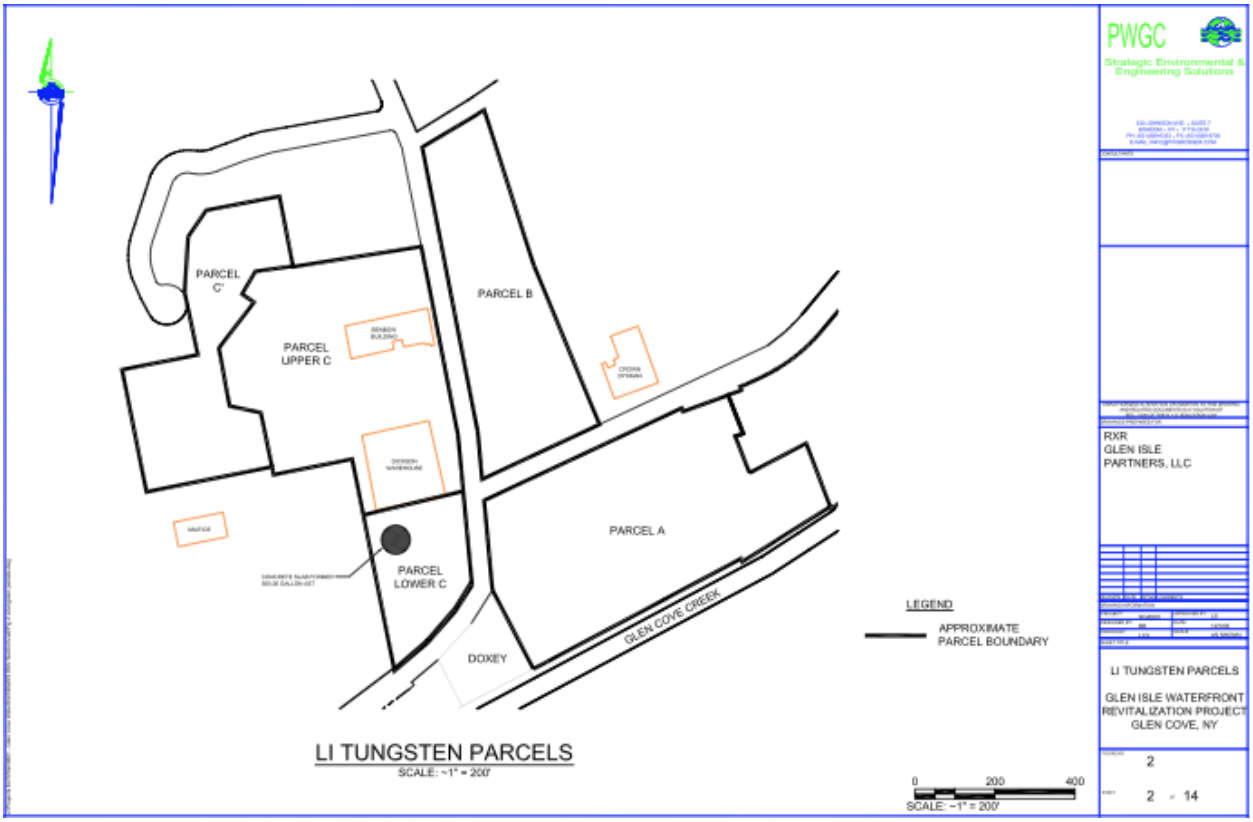
1.1 Site History

The Site has gone through several investigations and remedial efforts dating back to 1988. A *Record of Decision* (ROD) (EPA 1999) was issued in 1999 that presented the cleanup criteria that were applied during subsequent remedial efforts in 2001 and 2003. In 2005, an *Explanation of Significant Differences* (ESD) (EPA 2005) was issued that revised the 1999 criteria to the

currently accepted cleanup criteria on the Site (refer to Section 2.2). According to the U.S. Environmental Protection Agency (EPA), the Site currently satisfies the ESD criteria. However, in 2013, the NY State Department of Environmental Conservation (NYSDEC) and Department of Health (NYSDOH) identified potential radiological data gaps that required attention and resolution prior to NYS releasing the Site for development. Those data gaps were documented in *NYSDEC Data Gap Analysis Letter* dated November 8, 2013. In response, SEC prepared a Final Status Survey Plan (FSSP) that provided survey design and implementation guidelines for resolving the valid data gap concerns and for demonstrating that the data gap areas of the Site satisfy the 2005 ESD criteria. The *Li Tungsten Final Status Survey Plan* (SEC 2014) was approved by NYSDEC/NYSDOH on July 1, 2014.

Historically, the Site has been divided into three main parcels (**Figure 1-2**). This report relates to Parcel A, Parcel Lower C, and Parcel Upper C only. Parcel A is approximately 7 acres in size and is bounded by Glen Cove Creek to the south, Herb Hill Road to the north, Garvies Point Road and Doxey to the west, and 45 Herb Hill Road to the east. This parcel housed operating and processing facilities for the Li Tungsten Corporation. Parcels A and Lower C were remediated and verified as clean against the 2005 ESD radiological criteria by the EPA as documented in the 2008 *Remedial Action Report for Operable Unit One (Li Tungsten Facility)* (EPA 2008). However, data gap concerns related to the previous release surveys, including the demolished Lounge Building footprint, were identified by NYSDEC due to a FSS approach that was not in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (EPA 2000).

Figure 1-2. Li Tungsten Parcels



Parcel C is approximately 10 acres in size and is typically divided into two contiguous sections that are identified as Lower Parcel C and Upper Parcel C (Parcel C-Prime does not present a radiological hazard and is excluded from this FSSP). Parcel C is bordered by Dickson Street to the east (across from Parcel B), Garvies Point Road to the south, residential properties to the north, and undeveloped properties to the west. Parcel C was historically used for water treatment as well as some waste disposal operations.

2.0 CLEAN-UP STANDARDS AND BACKGROUND REFERENCE AREAS

2.1 Site Specific Clean-up Criteria

The applicable cleanup criteria for the Site were established in the 2005 ESD (EPA 2005). The 2005 criteria modified the 1999 ROD criteria (EPA 1999) by including an additional radium isotope [radium-228 (Ra-228)] and an additional thorium isotope [thorium-230 (Th-230)] to the original radium-226 (Ra-226) and thorium-232 (Th-232) radiological contaminants of concern (RCOCs). The 2005 ESD criteria consist of the following:

- Ra-226 combined with Ra-228: Less than 5 picoCuries/gram (pCi/g) above background.
- Th-230 combined with Th-232: Less than 5 pCi/g above background.

Note: There is no requirement for comparing the overall combination of the different elements (i.e., no "Sum-of-Ratio" requirement; rather, radium will be evaluated independently of thorium).

2.2 Background Reference Area

A background dataset was previously approved for use at the Site. This background dataset was established for the Parcel B and Upper Parcel C FSSs that were conducted between April 2006 and August 2007. Details of the background dataset were summarized in the 2009 Final Status Survey Report (FSSR):

> "*A background reference area is a geographical area from which representative samples of background conditions are selected for comparison with samples collected in specific survey units at the remediated site (NUREG-1505). The Project Health Physicist (HP) collected 11 background reference samples from a location with no indication of residual radioactive contamination and representative of the background radiological conditions for the geographic region. Background reference samples were obtained from a wooded and park-like area at 200 Dosoris Lane, Glen Cove, New York. The background sample results are presented as* ***Table 5-13*** [see **Table 2-1** of this FSSP] *and the sample values are also used in each Wilcoxon Rank Sum (WRS) Statistical Test.*"
>
> - *Final Status Survey Report* (TDY, 2009)

This background data set contains 11 sample points for use with the anticipated number of systematic sample locations (10) within each FSS survey unit (refer to **Section 3.2**).

The Background reference data set, along with pertinent statistics, is provided in **Table 2-1**. This data set serves two primary purposes:

1. To establish levels of regional background to be used for background subtraction when comparing sample results to the cleanup criteria.
2. To provide data points for use with the WRS Test when evaluating survey unit data.

Table 2-1. Background Reference Area Data

Sample Number	Ra-226 Result (pCi/g)	Ra-228 Result (pCi/g)	Ra-226 + Ra-228 (pCi/g)	Th-230 Result (pCi/g)	Th-232 Result (pCi/g)	Th-230 + Th-232 (pCi/g)
5601-BKGD-1001	0.68	1.32	2	0.79	0.73	1.52
5601-BKGD-1002	1.1	0.99	2.09	0.65	0.72	1.37
5601-BKGD-1003	0.8	1.07	1.87	0.59	0.62	1.21
5601-BKGD-1004	1.16	0.95	2.11	0.64	0.84	1.48
5601-BKGD-1005	0.94	0.77	1.71	0.55	0.68	1.23
5601-BKGD-1006	0.97	0.73	1.7	0.52	0.6	1.12
5601-BKGD-1007	0.93	0.68	1.61	0.47	0.7	1.17
5601-BKGD-1008	1.18	0.8	1.98	0.83	0.72	1.55
5601-BKGD-1009	0.94	0.86	1.8	0.5	0.75	1.25
5601-BKGD-1010	1.09	0.73	1.82	0.42	0.72	1.14
5601-BKGD-1011	1.01	0.58	1.59	0.43	0.54	0.97
Average	0.98	0.86	1.84	0.58	0.69	1.27
Standard Deviation	0.15	0.21	0.18	0.14	0.08	0.18
95% Confidence Level	1.28	1.28	2.21	0.85	0.86	1.64

2.3 Application of Criteria

The FSS soil sample results are compared directly against the cleanup criteria discussed in Section 2.1. Therefore, if all post-removal soil sample results have concentrations that are less than the cleanup criteria [referred to as derived concentration guideline level (DCGL)], the property is deemed radiologically appropriate for release and no further remediation is required. However, if any of the post-removal sample results exceed the release criteria, a strict statistical methodology called the Wilcoxon Rank Sum (WRS) test is performed to statistically compare the results to the DCGL plus background levels in accordance with guidance in MARSSIM (NRC 2000).

3.0 SURVEY UNIT DESIGN

Prior investigations, remedial efforts, FSSs, and a recent historical site assessment (HSA) were performed on the Site and were used as the basis for determining the area classifications established in this section. The historic Site data and the HSA were used to determine the current radiological status of the Site. Area classification decisions are made relative to the cleanup criteria as follows:

- **Class 1** areas are known or expected to have radionuclide concentrations above the cleanup criteria.

- **Class 2** areas are known or expected to have radionuclide concentrations above normal background concentrations but that are not expected to be above the cleanup criteria.
- **Class 3** areas are not expected to contain any residual radioactivity, or only contain levels that are a small fraction of the cleanup criteria.

As relates to pertinent areas of the Site addressed in the FSSP (Parcel A, Parcel Lower C, and building footprints on Parcel Upper C), all areas were classified as "Class 2" in accordance with the above MARSSIM definitions and the *Class 2 Justification Memorandum* (SEC 2014b). The pertinent area was therefore divided into six Class 2 survey units.

The recommended conditions for demonstrating compliance based on a Class 2 survey unit designation (MARSSIM Table 2.2) includes: systematic sampling (discrete samples), performing gamma scans over 10% to 100% of the survey unit, statistical testing (WRS Test), and elevated measurement comparison (EMC) evaluations. These parameters are discussed in greater detail through the remainder of this Section.

3.1 Survey Unit Size

MARSSIM recommends the maximum size for a Class 2 survey unit be limited to 10,000 square meters (m^2). Therefore, Parcel A was divided into three discrete survey units, each less than 10,000m^2. Parcel C was divided into an additional three units, one containing all of Parcel Lower C and two more encompassing the building footprints in Parcel Upper C. **Table 3-1** provides details on the size of each survey unit and the calculated sampling grid spacing.

Table 3-1. Sample Location Grid Spacing

Survey Unit Identification Study Area-Unit Number	Estimated Number of Sample Locations	Survey Unit Area (m^2)	Grid Spacing L (m)
SU-1	10	9,599	33
SU-2	10	9,950	34
SU-3	10	9,948	34
SU-4	10	6,695	28
SU-5	10	5,477	25
SU-6	10	3,431	20

3.2 Number of Samples per Survey Unit

Based on the frequency of discrete sample requirements in Section 4.2 of the FSSP, the number of discrete sample locations for each survey unit is derived in **Table 3-2**. The planned number of discrete sample locations was set based on the criterion that resulted in the largest number of required discrete sample locations. For Parcel A, the number of discrete sample locations required for each survey unit was calculated at 10.

The (Ra-226 + Ra-228) and the (Th-230 + Th-232) estimated minimum number of discrete sample locations is 10 and 9, respectively; therefore, the minimum number of discrete sample locations is based on either criteria and is set at **10** and includes a 20% buffer to account for lost samples and/or quality control (QC) purposes.

Grid Spacing

As specified in the FSSP, a triangular grid was established for each survey unit based on the unit's specific surface area in order to identify systematic sampling locations. The grid spacing for the survey unit was determined by the equation on the following page (Equation 5-7 from MARSSIM). Additionally, **Table 3-2** provides details for the subject survey units.

Table 3-2. Calculated Number of Discrete Sample Locations

Parameter	Ra-226+ Ra-228	Th-230+ Th-232
$DCGL_w$ (median derived concentration guideline level)	5.0 pCi/g	5.0 pCi/g
LBGR (lower bound of gray region)	2.5 pCi/g	2.5 pCi/g
Shift Δ ($DCGL_w$-LBGR)	2.5 pCi/g	2.5 pCi/g
Estimated Standard Deviation σ (1.5 x σ from 2014 Investigation sample results, per Master FSS Plan)	0.87 pCi/g	0.43 pCi/g
Relative Shift (Δ / σ)	2.84	6.44
Probability Function P_r (From MARSSIM Table 5.1, using the relative shift above)	0.974067	1.000000
Estimated Minimum Number of Discrete Sample Locations	10	9

Equation 5-7 from MARSSIM

$$L = \sqrt{\frac{A}{0.866(N)}}$$

Where:

L = triangular grid spacing for survey unit (m)
A = area of survey unit (m^2)
N = number of measurement locations

Once the grid spacing was determined, a random start point for locating the systematic sampling locations was established for each unit. Measuring the total dimensions of each survey unit and multiplying those dimensions by randomly selected values acquired the random start point.

4.0 FINAL STATUS SURVEY APPROACH

The primary purpose of the FSS is to demonstrate that the residual radionuclide concentrations at the Site comply with the concentration criteria in accordance with the decision documents. The objective of FSS activities is to obtain data of sufficient quality and quantity to support an evaluation of the criteria for the remediated properties. The methodology for collecting FSS measurements was derived from the MARSSIM-based approach as outlined in the *Li Tungsten Final Status Survey Plan.*

The FSS survey consisted of:

- Performance of a gamma walkover survey (GWS) over 100% of accessible areas.
- Collection and analysis of systematic surface soil samples to a depth of 6 inches.
- Collection and analysis of judgmental or "biased" soil samples to a depth of 6 inches.

4.1 Gamma Walkover Surveys

The first part of the FSS activities consisted of a GWS across the accessible portions of each survey unit. The GWS was performed in accordance with Section 5.3.1 of the Master FSSP, and in accordance with SEC procedure RP-104, *Radiological Surveys*.

The survey was performed by walking straight parallel lines approximately 1 meter (m) apart, while moving a Ludlum Model 44-10, 2-inch by 2-inch sodium iodide (NaI) gamma scintillation detector coupled to a Ludlum Model 2221 scaler/ratemeter in a serpentine motion, 2-3 inches above the ground surface. Data was logged automatically from the ratemeter/scaler along with measurement location determined with a global positioning system (GPS) unit every one second. A Trimble ProXT Differential GPS with Nomad was used to record gamma measurements and corresponding location data. The data was then downloaded from the GPS unit into a personal computer file and then into a geospatial software program to plot the results.

A screening limit of 15,000 counts per minute (cpm) (2-times ambient background) was used to identify potential areas of elevated radioactivity requiring further investigation.

4.1.1 Scan Minimum Detectable Concentration (MDC)

In order to ensure that field scanning equipment could adequately detect the contaminants of concern at the required levels, an MDC determination was necessary for the 2-inch x 2-inch NaI detectors. Calculated scan MDCs for a survey instrument equipped with 2x2 NaI scintillation detector using the MARSSIM two-stage scanning framework are summarized for a 15-centimeter (cm) thick contamination layer of Ra-226 and Th-232 in **Table 4-1**. The basis for the MDC calculations as they pertain to the MARSSIM are detailed in U.S. Nuclear Regulatory Commission Regulation (NUREG)-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions,* 1997, the default scan MDC values for Ra-226 and Th-232 are:

As shown in **Table 4-1**, the Scan-MDC for Ra-226 and Th-232 are comfortably below their respective DCGL values. Scan-MDCs using a 2x2 NaI detector and the scanning technique described above are expected to be significantly lower. Additionally, the absence of strong gamma emissions from Ra-228 and Th-230 is accounted for by reducing the "Single

Table 4-1. 2x2 NaI Scintillation Detector Scan-MDCs

Radionuclide	Actual Scan MDC (pCi/g)[a]	Single Radionuclide Cleanup Criteria (pCi/g)[b]
Ra-226[c]	2.3	2.5
Th-232[c]	1.5	2.5

[a] Background level, based on site-wide average (see **Table 4-2**), set at 6,544 counts per minute (cpm).
[b] Set to one-half the combination of Ra-226+Ra-228 and Th-230+Th-232, respectively.
[c] In equilibrium with progeny.

Radionuclide Cleanup Criteria" by one-half of the combined cleanup criteria (5.0 pCi/g). Ra-228 is a daughter of Th-232 and data presented in **Appendix B** of this FSSR support that they are in approximate equilibrium. Ra-226 is the daughter of Th-230 and data presented in **Appendix B** of this FSSR suggest that use of a 1-to-1-activity ratio between Ra-226 and Th-230 is conservative by overestimating the actual Th-230 activity by a factor of 1.84. This conservative overestimation of Th-230 activity, combined with the limited number of sample results above the investigation level (and no results above cleanup criteria), provides an adequate security buffer to justify our approach of not taking additional soil samples to compensate for the lack of Th-230 scanning.

4.1.2 Summary of GWS Results

Gross gamma count rates (inclusive of ambient background) ranged from approximately 3,323 cpm to 14,892 cpm. The statistics for each of the six units are provided below in **Table 4-2. Figure 4-1** provides a graphic display of the gamma count rate across the entirety of Parcel A as well as the discrete areas of Parcel Lower C and Parcel Upper C. The results of the GWS indicate the gamma levels across the Site are consistent with ambient background levels.

Table 4-2. Summary of GWS Statistics

Location	Number of Data Points	Minimum cpm	Maximum cpm	Average cpm
SU-1	27,097	3,973	9,789	6,174
SU-2	42,617	4,031	14,892	6,510
SU-3	37,694	3,808	11,749	6,312
SU-4	24,656	3,438	13,736	5,902
SU-5	20,366	3,323	13,836	7,455
SU-6	12,319	4,556	11,993	6,912

4.2 Surface Soil Sampling

Ten (10) systematic soil samples were taken in each survey unit to a depth of 15 cm using a stainless steel trowel. The sample was then placed into a stainless steel bowl and thoroughly mixed. Once the mixing was complete, the homogenized soil was placed into a labeled sample container then shipped by chain of custody (COC) to American Radiation Services (ARS) Laboratory in Port Allen, Louisiana (LA) for 21-day equilibrated gamma spectroscopy. Five percent of the samples were also analyzed by alpha spectroscopy for isotopic thorium to confirm secular equilibrium within the radium and thorium decay chains.

A supplemental sample effort was conducted in FSS Unit 01 as detailed in a letter dated 11/4/2014, *FSS Approach for East Warehouses* (SEC2014) (**Appendix D**). FSS Unit 01 contained a sub-surface slab, which included the basement of the former East Building. The slab is located about 8 feet below ground surface. Due to surface and ground water constraints, it was impractical to remove the slab to evaluate the soil beneath. Therefore, a supplemental group of samples was collected by Geoprobe®. A triangular grid was established and ten additional samples were collected. **Appendix D** provides further description and results of the sampling effort.

4.2.1 Biased Soil Samples

A total of 3 biased samples were collected during the course of field operations, including 1 sample from FSS Unit 01 and 2 from FSS Unit 03. The sample collected from FSS Unit 01 was taken following collection of a pre-FSS sample that was slightly elevated; further investigation of the area revealed no evidence of elevated activity and the bias sample results, together with the gamma walkover survey confirms the absence of elevated radioactivity. The two samples collected from FSS Unit 03 were also located during field screening activities and were less than the clean-up criteria, so no further action was required. The results of the biased samples are included in **Tables 4-3** and **4-5**.

4.2.2 EPA Exempt Areas Sub-Surface Soil Sampling

The NYSDEC identified six locations referenced in the EPA Remedial Action Completion Report, September 2008, (RACR) that were initially exempt from remediation, but subsequently remediated as described in the RACR. Four of the locations were on Parcel A and two on Parcel Lower C. The NYSDEC requested subsurface investigations to confirm compliance with the ESD clean-up criteria. These six locations are identified on the maps provided in **Appendix E.**

The subsurface investigations consisted of geoprobe sampling to a depth of approximately 8-feet below ground surface. Soil sleeves were removed and then scanned ex-situ using a Ludlum Model 44-10 2-inch x 2-inch NaI detector. Three soil samples were collected from each location representing the top 6-inches of the soil column, the bottom 6-inches of the column, and the section of column exhibiting the highest scan result. The samples were analyzed off-site by gamma spectroscopy (two were also analyzed for isotopic thorium) and the results are summarized in **Appendix E**. All results were below the ESD clean-up criteria inclusive of background.

4.2.3 Soil Sample Results

Tables 4-3 through **4-8** summarize the results of the FSS soil samples including the field duplicates and biased samples. All results are based on gamma spectroscopy. All results are in the units of pCi/gm.

Since no single sample within the six survey units exceeded the established release criteria (inclusive of background), no further statistical analyses were required.

Figure 4-1. GWS Results

Table 4-3. FS01 FSS Soil Sample Result Summary

Sample ID	Northing	Easting	Ra 226 + Ra 228	Th 230 + Th 232
FS01-01	253064.67	1084420.07	1.07	1.07
FS01-02	253159.24	1084365.47	1.52	1.52
FS01-03	253159.24	1084474.67	2.27	2.27
FS01-04*	253159.24	1084583.87	1.94	1.31
FS01-05	253253.81	1084310.87	1.59	1.59
FS01-06	253314.76	1084417.66	2.09	2.09
FS01-07	253253.81	1084529.27	1.76	1.76
FS01-08	253348.38	1084256.27	1.68	1.68
FS01-09	253348.38	1084365.47	3.56	3.56
FS01-10	253442.95	1084310.44	1.68	1.68
FS01-BIAS HOLE	253375.24	1084331.52	4.49	4.49
FS01-S01	253164.66	1084380.05	1.68	1.68
*FS01-S02**	253154.33	1084365.47	5.25	5.25
FS01-S03	253143.28	1084484.55	1.22	1.22
FS01-S04	253159.14	1084583.87	2.89	2.89
FS01-S05	253263.81	1084310.87	1.64	1.64
FS01-S06	253314.97	1084417.66	2.16	2.16
FS01-S07	253353.81	1084529.27	1.68	1.68
FS01-S08	253368.42	1084256.27	3.19	3.19
FS01-S09	253348.38	1084365.47	1.52	1.52
FS01-S10	253242.96	1084320.78	1.33	1.33
FS01-NP1	253375.24	1084331.48	3.05	3.05
FS01-NP2	253054.65	1084390.04	1.23	1.23
Bold = Systematic Sample		**Mean**	**1.94**	**1.87**
Italics = QA or Biased Sample		**Std Dev**	**0.66**	**0.69**

Asterisk(*) denotes samples also analyzed via Alpha Spec for isotopic Thorium.

Note: only systematic samples were used for mean and standard deviation calculations. Data inclusive of regional background. Sample FS01-S04 is below Cleanup criteria when background of 1.84 pCi/g Ra-226+Ra-228 and 1.27 pCi/g Th-232+Th230 is applied.

Table 4-4. FS02 FSS Soil Sample Result Summary

Sample ID	Northing	Easting	Ra 226 + Ra 228	Th 230 + Th 232
FS02-01*	252974.88	1084116.74	0.95	1.00
FS02-01D	252974.88	1084116.74	2.38	2.38
FS02-02	252974.88	1084227.94	1.81	1.81
FS02-03	253071.18	1084061.14	1.71	1.71
FS02-04	253071.18	1084172.34	1.90	1.90
FS02-05	253071.18	1084283.54	2.49	2.49
FS02-06	253167.48	1084116.74	2.28	2.28
FS02-07	253167.48	1084227.94	1.14	1.14
FS02-08	253263.79	1084061.14	0.88	0.88
FS02-09	253263.79	1084172.34	4.63	4.63
FS02-10*	253360.09	1084116.74	1.43	1.97
Bold = Systematic Sample		**Mean**	**1.92**	**1.98**
Italics = QA or Biased Sample		**Std Dev**	**1.09**	**1.07**

Asterisk(*) denotes samples also analyzed via Alpha Spec for isotopic Thorium.

Note: only systematic samples were used for mean and standard deviation calculations. Data inclusive of regional background.

Table 4-5. FS03 FSS Soil Sample Result Summary

Sample ID	Northing	Easting	Ra 226 + Ra 228	Th 230 + Th 232
FS03-01	252822.01	1083884.00	0.13	0.13
FS03-01D	252822.01	1083884.00	0.73	0.73
FS03-02	252919.01	1083828.00	1.21	1.21
FS03-03	252919.01	1083940.00	1.27	1.27
FS03-04*	252919.01	1084052.00	1.62	1.11
FS03-05	253016.00	1083884.00	2.03	2.03
FS03-06	253016.00	1083996.00	0.91	0.91
FS03-07*	253112.99	1083828.00	2.15	1.12
FS03-08	253112.99	1083940.00	1.75	1.75
FS03-09	253209.99	1083884.00	1.58	1.58
FS03-10*	253209.99	1083996.00	1.58	1.03
FS03-B01	253174.78	1083964.28	0.24	3.14
*FS03-B02**	253174.78	1083964.28	0.25	0.69
Bold = Systematic Sample		**Mean**	**1.42**	**1.21**
Italics = QA or Biased Sample		**Std Dev**	**0.59**	**0.52**

Asterisk(*) denotes samples also analyzed via Alpha Spec for isotopic Thorium.

Note: only systematic samples were used for mean and standard deviation calculations. Data inclusive of regional background.

Table 4-6. FS04 FSS Soil Sample Result Summary

Sample ID	Northing	Easting	Ra 226 + Ra 228	Th 230 + Th 232
FS04-01	252848.00	1083566.00	1.23	1.23
FS04-02	252926.98	1083520.40	1.29	1.29
FS04-03	252926.98	1083611.60	1.30	1.30
FS04-04	252926.98	1083702.80	2.60	2.60
FS04-05	253005.96	1083566.00	1.36	1.36
FS04-06	253005.96	1083657.20	2.11	2.11
FS04-06D	253005.96	1083657.20	0.85	0.85
FS04-07*	253084.94	1083520.40	1.47	1.10
FS04-08	253084.94	1083611.60	0.82	0.82
FS04-09	253084.94	1083702.80	1.24	1.24
FS04-10	253163.93	1083657.20	0.91	0.91
		Mean	**1.43**	**1.40**
		Std Dev	**0.54**	**0.55**

Bold = Systematic Sample

Italics = QA or Biased Sample

Asterisk(*) denotes samples also analyzed via Alpha Spec for isotopic Thorium.

Note: only systematic samples were used for mean and standard deviation calculations. Data inclusive of regional background.

Table 4-7. FS05 FSS Soil Sample Result Summary

Sample ID	Northing	Easting	Ra 226 + Ra 228	Th 230 + Th 232
FS05-01	253184.00	1083510.00	2.31	2.31
FS05-02	253184.00	1083592.35	2.41	2.41
FS05-03*	253184.00	1083674.70	2.62	1.50
FS05-04*	253255.32	1083551.18	3.05	2.02
FS05-05	253255.32	1083633.53	2.71	2.71
FS05-06	253255.32	1083715.88	3.19	3.19
FS05-07	253326.63	1083510.00	2.87	2.87
FS05-08	253326.63	1083592.35	1.34	1.34
FS05-08D	253326.63	1083592.35	0.83	0.83
FS05-09	253326.63	1083674.70	2.56	2.56
FS05-10	253397.95	1083633.53	3.52	3.52
		Mean	**2.66**	**2.44**
		Std Dev	**0.59**	**0.69**

Bold = Systematic Sample

Italics = QA or Biased Sample

Asterisk(*) denotes samples also analyzed via Alpha Spec for isotopic Thorium.

Note: only systematic samples were used for mean and standard deviation calculations. Data inclusive of regional background.

Table 4-8. FS06 FSS Soil Sample Result Summary

Sample ID	Northing	Easting	Ra 226 + Ra 228	Th 230 + Th 232
FS06-01*	253563.00	1083469.00	0.35	1.51
FS06-02	253563.00	1083534.29	2.89	2.89
FS06-03	253563.00	1083599.58	3.85	3.85
FS06-04	253619.54	1083436.36	1.98	1.98
FS06-05	253619.54	1083501.65	3.01	3.01
FS06-05D	253619.54	1083501.65	2.70	2.70
FS06-06	253619.54	1083566.94	3.07	3.07
FS06-07	253619.54	1083632.23	2.65	2.65
FS06-08	253676.09	1083469.00	1.19	1.19
FS06-09	253676.09	1083534.29	2.60	2.60
FS06-10	253676.09	1083599.58	1.76	1.76
		Mean	**2.33**	**2.45**
		Std Dev	**1.03**	**0.82**

Bold = Systematic Sample

Italics = QA or Biased Sample

Asterisk(*) denotes samples also analyzed via Alpha Spec for isotopic Thorium.

Note: only systematic samples were used for mean and standard deviation calculations. Data inclusive of regional background.

5.0 DATA QUALITY ASSESSMENT

The FSS samples for Parcel A, Parcel Lower C, and Parcel Upper C were collected August 19, 2014 through December 19, 2014. The field events conformed to the specifications of the Li Tungsten FSSP (SEC 2014).

The samples were analyzed by ARS Laboratory which is certified through the National Environmental Laboratory Accreditation Program (NELAP) which is administered through the NYDOH.

Sixty systematic field samples, five field duplicates, and three biased samples were collected. Soil samples were quantified for radium and thorium isotopes by gamma spectroscopy method EPA 901.1M and 5% were analyzed by alpha spectroscopy method Eichrom ACW-10 for isotopic thorium to confirm our assumption of secular equilibrium within the uranium decay chain. Results of alpha spectroscopy analysis indicate that the assumption of secular equilibrium is conservative, and that by assuming such, we are actually overestimating the Th-230 activity by an average factor of 1.84; and overestimating the Ra-228 activity by an average factor of 1.04.

5.1 PARCC Parameters

The QA/QC parameters of precision, accuracy, representativeness, completeness, and comparability are referred to as PARCC. Data quality can be evaluated by how well the PARCC parameters met the Data Quality Objectives (DQOs). The following summarizes the evaluation of each parameter.

Precision is measured through laboratory replicate, and field duplicate, results. Laboratory replicates were performed by the contract laboratory and the results of the evaluation were included along with each data package. The laboratory evaluated their replicate/duplicate pairs by performing Replicate Error Ratio, Duplicate Error Ratio, and Relative Percent Difference analyses; their internal acceptance criteria were <1, <3, and ≤ 25%, respectively. The laboratory's evaluations, presented in **Appendix B**, indicate excellent precision with no data exceeding the acceptable parameters for both alpha spec and gamma spec. Field duplicates are primarily indicative of the precision associated with sample collection methodology, but also provide an indication of precision associated with sample preparation and analysis. Five pairs of field duplicates were collected, and their precision was evaluated by comparing their results to see if they were within a factor of 4 of each other. All field replicate pairs passed this evaluation, indicating that adequate precision was achieved.

Accuracy is defined as the closeness of a measurement to its true value and it is checked by analyzing samples of known activity through laboratory control sample analysis and or matrix spikes. The laboratory reported results of their laboratory control samples and matrix spikes (alpha spec only) within each data package in **Appendix B**. All results indicate that the laboratory had excellent accuracy.

Representativeness is dependent upon the number and locations of collected samples, as well as the method of sample preparation. Whether a given sample or group of samples are representative of a given area (i.e., SUs) depends upon how the contamination is distributed throughout that area, the type of contaminants, and the range of contaminant concentrations or

activities. Using the MARSSIM-based approach statistically ensures that samples collected and analyzed are representative of the residual contamination for a given SU. Similarly, the more homogeneous the collected sample, the greater likelihood that a representative sample aliquot will be taken from the sample container by the lab technician for analysis. All FSS samples were dried and ground (the grinding process homogenizes the sample). Representativeness of samples is also supported by comparing sample results to the GWS of each survey unit. Additionally, the parameters of precision and accuracy can be used as an indication of representativeness. Based on a review of all the data, there is a strong body of evidence to suggest that the representativeness parameter has been adequately satisfied; the sample collection and preparation method has been shown to yield representative aliquots; the MARSSIM-based sampling approach provides an acceptable statistical representation of a survey unit; and the associated precision and accuracy parameters, which are all within QC limits, support that conclusion that data are representative of residual radioactivity within each survey unit.

Completeness of the data is measured by the percentage of usable data relative to the total number of samples collected. No data was rejected by the contract laboratory and all data is acceptable; therefore, completeness for FSS data is 100%.

Comparability refers to the ability of a laboratory to reproduce results that agree with results from another laboratory. Comparability is measured through the preparation and analysis of performance evaluation samples. The contract laboratory (ARS, Inc.) is a NELAP-certified laboratory and must pass annual performance evaluation sample analyses for all radio-analytical procedures to maintain certification. Therefore, active certification indicates that the contract laboratory has adequately satisfied the comparability parameter.

The overall result of the data quality evaluation indicates that a high level of data quality exists for the FSS data, as evidenced by the satisfaction of all PARCC parameters.

6.0 FINAL EVALUATION OF DATA AND CONCLUSION

All data obtained during this FSS was done in accordance with the FSSP. The classification of the survey unit by contamination potential (Class 2) was appropriate. The maximum gamma reading in the survey unit was 14,892 cpm, compared to the 15,000 cpm screening level.

The number of data points obtained in each survey unit was reviewed relative to the design basis of 10. There were 60 systematic sample points originally identified on the grid sampling plan. An additional 8 sample points were added to account for QC duplicates and biased samples. In all, a total of 68 samples were obtained and analyzed across the six survey units. Since no single sample exceeded the established clean-up criteria for total radium or total thorium, no statistical analysis such as the Sign Test or WRS Test was required in any survey unit.

Finally, a retrospective assessment of the relative shift was performed to confirm the FSS design basis. This assessment was performed for Survey Unit 5 as this unit contained the highest combined residual concentrations of total radium and total thorium. Average concentrations (unadjusted for background contributions to assure conservatism) and associated standard deviations of radionuclide concentrations in Survey Unit 5 were determined and substituted for the LBGR and sigma in the relative shift calculation. The resulting relative shift value for Ra-226 plus Ra-228 is 3.96 [(5.0 – 2.66) / 0.59] and the relative shift value for Th-232 plus Th-230 is

3.71 [(5.0 – 2.44) / 0.69].These relative shift values, which are conservatively based on gross sample activity (i.e., no background subtraction was performed), combined with the decision error limits established in the FSSP (alpha/beta = 0.05) yield a minimum requirement of eight (8) survey unit samples (i.e., N/2 = 8) in accordance with MARSSIM Equation 5-1. Since 10 samples were collected from each survey unit, sufficient statistical strength exists to exceed the data quality objectives of the FSSP and to allow conclusions to be made regarding to the residual radioactivity status of each survey unit. The results of the retrospective assessment combined with the data assessment and evaluation process presented in this report and performed in accordance with MARSSIM, the null hypothesis is rejected. The alternate hypothesis (i.e., that the residual activity satisfies the ESD clean-up criteria) is therefore accepted.

This evaluation thus demonstrates that the final radiological status of Parcel A, Parcel Lower C, and Parcel Upper C satisfies the requirement for unrestricted use without radiological restrictions and that no further radiological monitoring should be required at the Li Tungsten Site.

7.0 REFERENCES

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APPENDIX A

Final Status Survey Plan

FINAL STATUS SURVEY PLAN

Li Tungsten Site
683 Herb Hill Road
Glen Cove, New York 11542

CERCLIS ID: NYD986882660
NYS Site Code: 130046

FSSP (Rev. 0)
July 2014

Prepared for:
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Prepared by:
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Final Status Survey Plan
Li Tungsten Site, Glen Cove, New York

CERCLIS ID: NYD986882660 – NYS Site Code: 130046

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

bgs	below ground surface
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cm	centimeter
CoC	Chain of Custody
cpm	counts per minute
DCGL	Derived Concentration Guideline Level
DQO	Data Quality Objective
ELAP	Environmental Laboratory Approval Program
EMC	Elevated Measurement Comparison
EPA	US Environmental Protection Agency
ESD	Explanation of Significant Differences
FSS	Final Status Survey
FSSP	Final Status Survey Plan
ft	foot/feet
GWS	Gamma Walkover Survey
HSA	Historical Site Assessment
LBGR	Lower-Bound Gray Region
m	meter
m^2	meter squared
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
MDCR	Minimum Detectable Count Rate
$MDCR_S$	Minimum Detectable Count Rate-Surveyor
NaI	Sodium Iodide
NIST	National Institute of Standards and Technology
No.	Number
NPL	National Priorities List
NY	New York
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
pCi	picoCuries
PESI	Perma-Fix Environmental Services, Inc.
PWG	P.W. Grosser, Inc.
QA	Quality Assurance

QAP	Quality Assurance Program
QAPP	Quality Assurance Project Plan
QC	Quality Control
Ra-226	Radium-226
Ra-228	Radium-228
RCOC	Radiological Contaminant of Concern
ROD	Record of Decision
Th-230	Thorium-230
Th-232	Thorium-232
US	United States
WRS	Wilcoxon Rank Sum

1.0 INTRODUCTION

Safety and Ecology Corporation Services, Inc., wholly owned subsidiary of Perma-Fix Environmental Services, Inc. (PESI) has been selected to conduct Final Status Survey (FSS) at the historic Li Tungsten Superfund Site (Site) located at 683 Herb Hill Road Glen Cove, New York (NY); roughly 25 miles east-northeast of New York City (**Figure 1-1**). The Site is identified on the *National Priorities List* (NPL) as "Li Tungsten Corp." with the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number NYD986882660. The Site is also listed as a Class 2 Inactive Hazardous Waste Site, identified as "Li Tungsten" within the NY State Superfund Program, with Site Code number 130046.

The Site has gone through several investigations and remedial efforts dating back to 1988. A *Record of Decision* (ROD) (EPA, 1999) was issued in 1999 that presented the cleanup criteria that were applied during subsequent remedial efforts in 2001 and 2003. In 2005, an *Explanation of Significant Differences* (ESD) (EPA, 2005) was issued that revised the 1999 criteria to the currently accepted cleanup criteria on the Site (Refer to Section 2.2). According to the U.S. Environmental Protection Agency (EPA), the site currently satisfies the ESD criteria. However, in 2013, the NY State Department of Environmental Conservation (NYSDEC) and Department of Health (NYSDOH) identified potential radiological data gaps that require attention and resolution prior to NYS releasing the Site for development. This Final Status Survey Plan (FSSP) presents the design and implementation guidelines for resolving valid data gap concerns and for demonstrating that the data-gap areas of the Site satisfy the 2005 ESD criteria.

Historically, the site has been divided into three main parcels (**Figure 1-2**).

- Parcel A is approximately 7 acres in size and is bounded by Glen Cove Creek to the south, Herb Hill Road to the north, Dickson Street and Doxey to the West, and the Gateway Properties to the east. This parcel housed operating and processing facilities for the Li Tungsten Corporation. Parcel A was remediated and verified as clean against the 2005 ESD radiological criteria by the EPA as documented in the 2008 *Remedial Action Report for Operable Unit One (Li Tungsten Facility)* (EPA, 2008). Parcel A represents a data gap concern for NYSDEC due to a final status survey (FSS) approach that was not in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (EPA, 2000). Additionally, the footprint of the recently demolished Lounge Building was identified as a potential data gap.

- Parcel B is approximately 6 acres in size and is located to the north of Parcel A, with Herb Hill Road forming its southern boundary. Other bounds of Parcel B include Dickson Street to the west, 'The Place" Street to the north, and Crown Dykman to the east. Parcel B was a primarily undeveloped land area that was used for parking and some waste disposal operations. Following remediation, Parcel B was subject to an FSS in accordance with MARSSIM (EPA, 2000), and was verified as radiologically clean as documented in the *Post-Remedial Actions at parcel B and Upper parcel C Li Tungsten Superfund Site, Glen Cove, New York* (TDY, 2009). Parcel B does not contain data gaps and the MARSSIM data support its radiologically-clean status; therefore, no further FSS activities on Parcel B are necessary.

- Parcel C is approximately 10 acres in size and is typically divided into two contiguous sections that are identified as Lower Parcel C and Upper Parcel C (Parcel C-Prime does not present a radiological hazard and is excluded from this FSSP). Parcel C is bordered by Dickson Street to the east (across from Parcel B), Garvies Point Road to the south, residential properties to the north, and undeveloped properties to the west. Parcel C was historically used for water treatment as well as some waste disposal operations.

    - Upper Parcel C was subject to an FSS in accordance with MARSSIM (EPA, 2000), and was verified as radiologically clean as documented in the *Post-Remedial Actions at parcel B and Upper parcel C Li Tungsten Superfund Site, Glen Cove, New York* (TDY, 2009). However, the footprints of the recently demolished Benbow Building and Dickson Warehouse represent potential data gaps that will be addressed in this FSSP. It should be noted that a sub-slab investigation was performed beneath Dickson Warehouse in 2014.

    - Lower Parcel C was remediated and verified as clean against the 2005 ESD radiological criteria by the EPA as documented in the 2008 *Remedial Action Report for Operable Unit One (Li Tungsten Facility)* (EPA, 2008). Lower Parcel C represents a data gap concern for NYSDEC because the final status survey (FSS) was not in accordance with MARSSIM (EPA, 2000).

Radionuclide Contaminants of concern (RCOCs) on the Site include Radium-226 (Ra-226), Radium-228 (Ra-228), Thorium-230 (Th-230), and Thorium-232 (Th-232). This FSSP includes a means to statistically evaluate soil contamination levels for residual RCOCs by using the MARSSIM process. This process includes a historical site assessment, the establishment of data quality objectives, release criteria, FSS design, data evaluation, and the method for making conclusions as to the status of the site relative to the release criteria. The primary objective of this data collection effort is to, in a timely manner, effectively demonstrate the radiological status of the Site relative to the 2005 ESD criteria (EPA, 2005).

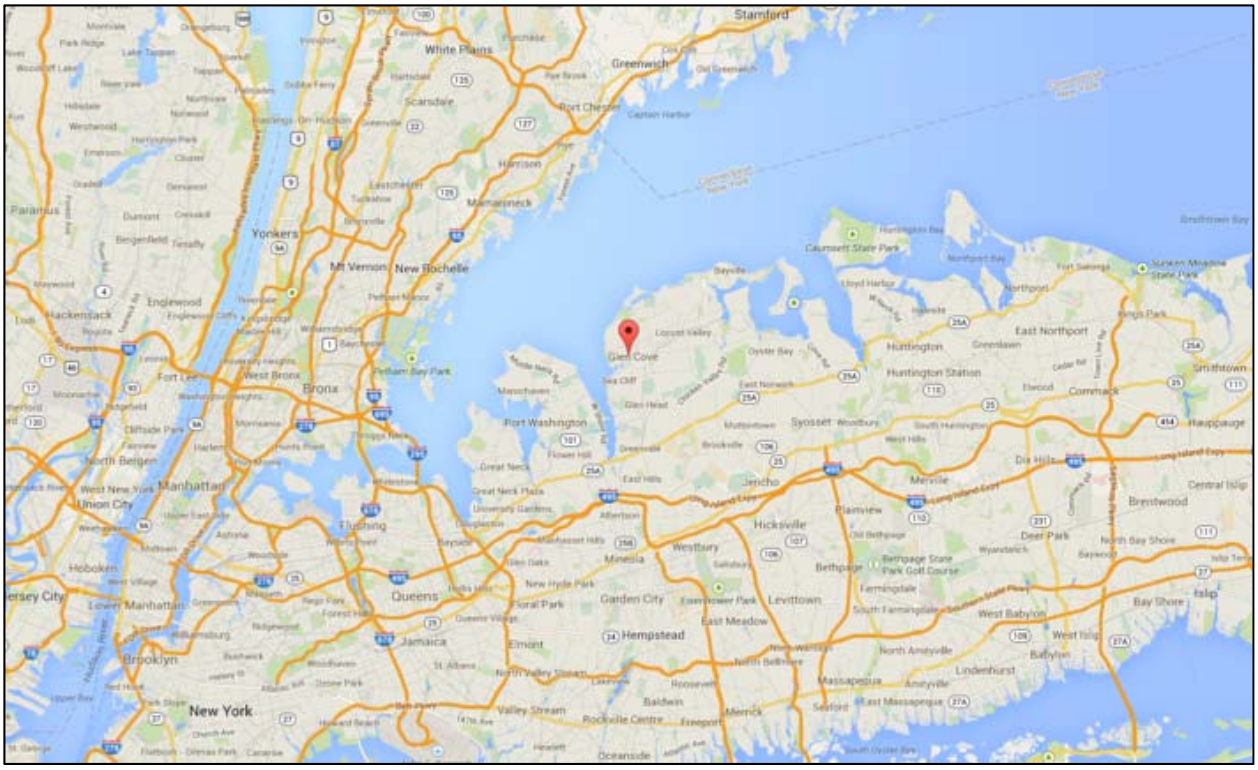

Figure 1-1: Li Tungsten Site Location

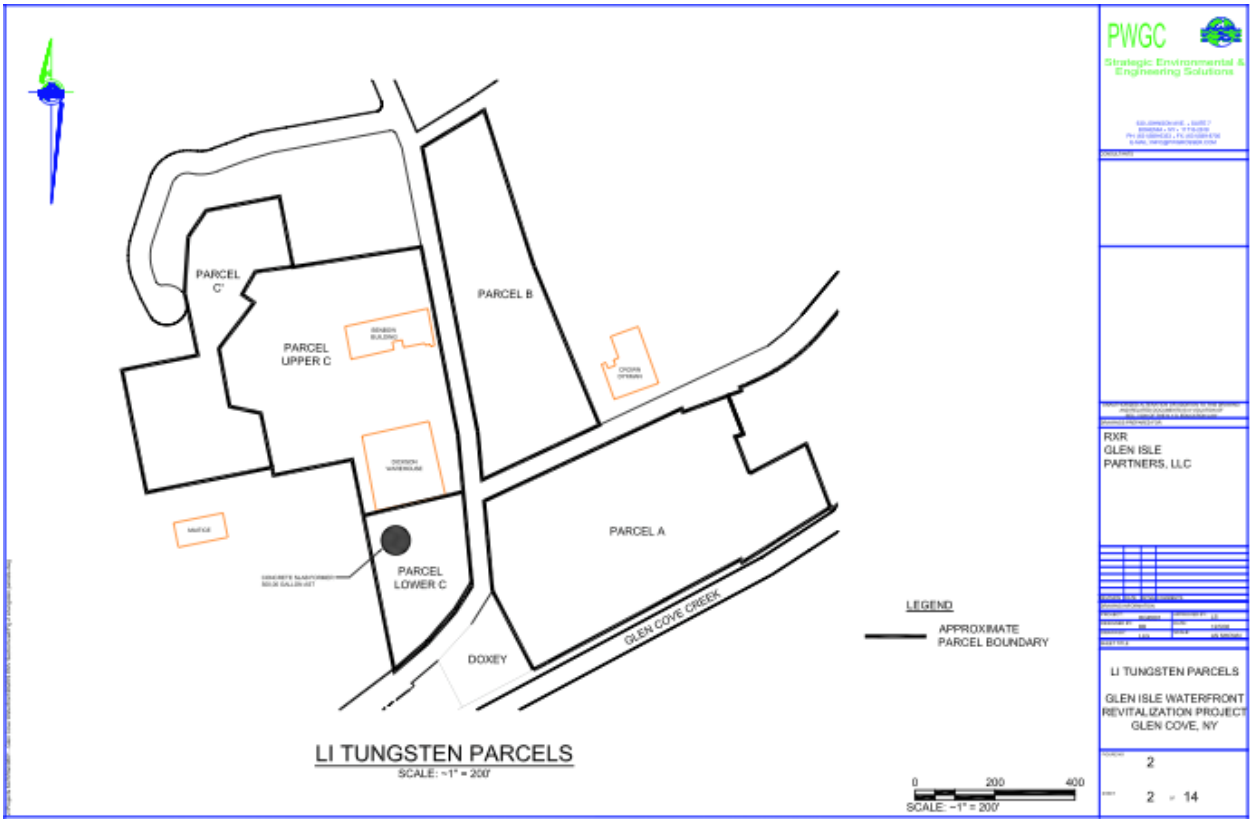

Figure 1-2: Li Tungsten Parcels

2.0 PRELIMINARY CONSIDERATIONS

2.1 Historical Site Assessment

A robust historical site assessment (HSA) was performed leading up to the development of this FSSP as documented in the *Li Tungsten Data Gap Review and Response to DEC/DOH Comments and Recommendations for Parcels A, B, and C, and Captains Cove* (SEC, 2014a), and the *Justification for Class 2 Survey Units on Parcel A and Lower Parcel C at Li Tungsten, Site No. 130046* (SEC, 2014b). Pertinent findings are summarized here:

- Fred C. Hart and Associates performed site-wide gamma scan surveys as a first step in site characterization as far back as 1988. The actual gamma readings were not available for review, but various documents (see SEC, 2014a) indicate that the results of these gamma surveys were used to delineate remediation areas on Parcel A and Lower Parcel C.
- In accordance with the 1999 ROD (EPA, 1999), Parcel A and Lower Parcel C were remediated by the EPA in 2001. During final verification, all but three areas were successfully remediated to meet 1999 ROD criteria based on composite sample results. These three "exempt" areas were addressed during a subsequent remedial effort in 2003 and all three areas were successfully remediated to meet 1999 ROD criteria based on composite sample results.
- Also in 2003, a comprehensive surface and subsurface investigation was performed in all Parcels and no radiological exceedances were identified (Metron, 2004).
- In 2005, the ESD modified the release criteria as presented in the 1999 ROD. EPA reviewed all the existing data against the new criteria and determined that the new criteria were satisfied (EPA, 2008).
- A MARSSIM FSS was performed on Parcel B and Upper Parcel C between 2006 and 2007, which demonstrated that both excavated and unexcavated areas of these parcel's satisfied the 2005 ESD criteria (TDY, 2009).
- In 2014, another comprehensive surface and subsurface investigation was performed that again identified no radiological exceedances (PWG, 2014).

Despite all the indications that Parcel A and Lower Parcel C meet the 2005 ESD criteria, there is not enough data available currently to perform an evaluation in accordance with MARSSIM. Therefore, it was recommended that Parcel A and Lower Parcel C undergo a MARSSIM FSS (SEC, 2014a).

Parcel B and Upper Parcel C have undergone fully-compliant MARSSIMs surveys and have statistically significant data to support a release decision. Therefore, no further FSS is recommended for Parcel B and Upper Parcel C, with the exception of the footprints of recently demolished buildings located on Upper Parcel C.

2.2 Cleanup Criteria

The applicable cleanup criteria for the Site were established in the 2005 ESD (EPA, 2005). The 2005 criteria modified the 1999 ROD criteria (EPA, 1999) by including an additional radium isotope (Ra-228) and an additional thorium isotope (Th-230) to the original Ra-226 and Th-232 RCOCs. The 2005 ESD criteria consist of the following:

- Ra-226 combined with Ra-228: Less than 5 pCi/g above background.
- Th-230 combined with Th-232: Less than 5 pCi/g above background.

These are the cleanup criteria that will be applied during the data evaluation phase of the FSSP. Comparisons of FSS data sets to these criteria will be used to support release decisions.

Note that there is no requirement for comparing the overall combination of the different elements (i.e., no "Sum-of-Ratio" requirement; rather, radium will be evaluated independently of thorium).

2.3 Background Activity

A background dataset has previously been approved for use at the Site. This background dataset was established for the Parcel B and Upper Parcel C Final Status Surveys that were conducted between April 2006 and August 2007. Details of the background dataset were summarized in the 2009 Final Status Survey Report:

> "*A background reference area is a geographical area from which representative samples of background conditions are selected for comparison with samples collected in specific survey units at the remediated site (NUREG-1505). The Project Health Physicist (HP) collected 11 background reference samples from a location with no indication of residual radioactive contamination and representative of the background radiological conditions for the geographic region. Background reference samples were obtained from a wooded and park-like area at 200 Dosoris Lane, Glen Cove, New York. The background sample results are presented as* ***Table 5-13*** [see **Table 2-1** of this FSSP] *and the sample values are also used in each Wilcoxon Rank Sum (WRS) Statistical Test.*"
>
> - *Final Final Status Survey Report* (TDY, 2009)

This background data set contains 11 sample points, which is sufficient – based on this FSSP design – for use with the anticipated number of systematic sample locations (10) within each FSS survey unit (refer to **Section 4.2**).

The Background reference data set, along with pertinent statistics, is provided in **Table 2-1**. This data set serves two primary purposes:

1. To establish levels of regional background to be used for background subtraction when comparing sample results to the cleanup criteria.
2. To provide data points for use with the WRS Test when evaluating survey unit data.

In the event that more background data is needed, additional reference area data may be collected to augment this data set. Additionally, Data may be collected to establish background gross gamma readings for surface and/or down-hole gamma logging as appropriate.

Table 2-1: Background Reference Area Data

Sample Number	Ra-226 Result (pCi/g)	Ra-228 Result (pCi/g)	Ra-226 + Ra-228 (pCi/g)	Th-230 Result (pCi/g)	Th-232 Result (pCi/g)	Th-230 + Th-232 (pCi/g)
5601-BKGD-1001	0.68	1.32	2	0.79	0.73	1.52
5601-BKGD-1002	1.1	0.99	2.09	0.65	0.72	1.37
5601-BKGD-1003	0.8	1.07	1.87	0.59	0.62	1.21
5601-BKGD-1004	1.16	0.95	2.11	0.64	0.84	1.48
5601-BKGD-1005	0.94	0.77	1.71	0.55	0.68	1.23
5601-BKGD-1006	0.97	0.73	1.7	0.52	0.6	1.12
5601-BKGD-1007	0.93	0.68	1.61	0.47	0.7	1.17
5601-BKGD-1008	1.18	0.8	1.98	0.83	0.72	1.55
5601-BKGD-1009	0.94	0.86	1.8	0.5	0.75	1.25
5601-BKGD-1010	1.09	0.73	1.82	0.42	0.72	1.14
5601-BKGD-1011	1.01	0.58	1.59	0.43	0.54	0.97
Average	0.98	0.86	1.84	0.58	0.69	1.27
Standard Deviation	0.15	0.21	0.18	0.14	0.08	0.18
95% Confidence Level	1.28	1.28	2.21	0.85	0.86	1.64

Note: Table reproduced from *Final Status Survey Report* (TDY, 2009)

2.4 Characterization Data

Characterization data for the Site was reviewed during the HSA and included several sources of information that gave a broad scope of radiological conditions in the both the surface and subsurface. These sources of information were summarized in the *Li Tungsten Data Gap Review and Response to DEC/DOH Comments and Recommendations for Parcels A, B, and C, and Captains Cove* (SEC, 2014a), and the *Justification for Class 2 Survey Units on Parcel A and Lower Parcel C at Li Tungsten, Site No. 130046* (SEC, 2014b). These documents are available for review online at https://www.dropbox.com/sh/jspccbmhlrmgw2o/ffYEgtKTi4. In general, the information indicates that no surveyed areas of the Site contain above-criteria RCOCs concentrations. However, the recent 2014 investigation provides the best analytical data, and was therefore used for the purposes of designing MARSSIM surveys in accordance with this FSSP.

During the 2014 investigation, 28 samples were analyzed via alpha spectrometry and gamma spectrometry. These samples were collected from locations throughout the site and complete analytical data is provided in **Attachment 1**. **Table 2-2** provides a summary of the radium and thorium data pertinent to this FSSP. This data was used as a means to estimate the anticipated variability of the of the FSS data sets. Variability (sigma, σ) is a key parameter of interest for designing MARSSIM surveys; the variability of the characterization data is used to estimate the minimum sampling requirements for each FSS survey unit.

Table 2-2: 2014 Analytical Data Summary

Sample ID	Radium-226 + Radium-228	Thorium-230 + Thorium-232
LT-C-013	2.021	1.564
LT-C-066	2.226	1.338
LT-G-029	2.858	1.573
LT-XC-020	1.452	0.796
LT-C-018	1.818	1.425
LT-C-067	0.986	0.701
LT-G-029	2.858	1.573
LT-XC-020	1.452	0.796
LT-C-045	1.51	0.75
LT-X-002	1.462	1.371
LT-R-001	2.422	1.026
LT-XC-021	0.619	0.47
LT-C-048	1.254	0.583
LT-G-019	1.098	0.473
LT-R-001	2.861	1.429
LT-XC-023	1.312	0.768
LT-C-049	1.608	0.864
LT-G-026	1.304	0.756
LT-R-002	1.735	0.86
LT-C-060	1.056	0.667
LT-G-027	2.413	0.738
LT-R-002	1.629	1.345
LT-C-064	1.386	0.78
LT-G-028	4.0	1.758
LT-R-003	1.374	1.193
LT-C-065	1.669	1.066
LT-G-029	3.62	1.734
LT-R-003	1.452	1.099
Average	1.791	1.019
STDEV	0.883	0.388
Min	0.619	0.470
Max	4.000	1.758

3.0 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements that establish a systematic procedure for defining the criteria by which data collection design is satisfied in order to support release decisions for a survey unit. The DQOs at the Site include:

- Clarifying the problem;
- Defining the data necessary for achieving the end use decisions;
- Determining the appropriate method of data collection; and
- Specifying the level of decision errors acceptable for establishing the quantity and quality of data needed to support the project decisions.

The overall Quality Assurance (QA) objective for this FSSP is to develop and implement a methodology for obtaining and evaluating data that meet the DQOs to evaluate whether the cleanup criteria are satisfied. Specifically, radionuclide data will be generated to demonstrate that the Site has achieved the remediation criteria. QA procedures are established to ensure that field measurements, sampling methods, and analytical data provide information that is comparable and representative of actual field conditions, and that the data generated are technically defensible.

To determine DQOs, a series of planning steps are used, as specified in the U.S. Environmental Protection Agency (EPA) Guidance for Data Quality Objective Process QA/G-4 (EPA, 2006), to identify the data needed to support project decisions and develop a data collection methodology. The process is intended to be iterative, optimizing data collection to meet the applicable decision criteria.

3.1 State the Problem

The Site has been extensively investigated, remediated, and evaluated via FSS; however, data gaps exist due to: (1) FSS surveys that were not performed in accordance with MARSSIM, and (2) inaccessible regions underneath buildings that were still standing at the time of previous surveys; these buildings have subsequently been demolished thereby making the ground surface within each building footprint accessible.

RCOCs at the Site have been identified as Ra-226 + Ra-228, and Th-230 + Th-232. The currently accepted cleanup criteria, as promulgated in the 2005 ESD (EPA, 2005), and as stated in **Section 2.2** of this FSSP, is 5.0 pCi/g above background for each nuclide pair.

The "problem" therefore is to demonstrate that the identified data gap areas satisfy, or dissatisfy, the cleanup criteria for the RCOCs. Therefore, the goal of this FSSP is to design a survey methodology, in accordance with MARSSIM, which will demonstrate with a level of confidence, the residual activity of RCOCs relative to the 2005 cleanup criteria.

3.2 Identify the Decision

The surveys will be designed to provide adequate data for making statistically defensible decisions regarding the release status of the Site. If the survey data indicates that the Site satisfies cleanup criteria then no further action is required relative to radiological contamination. If the

data indicates that the residual contamination exceeds cleanup criteria, then additional evaluations, investigation, and/or remediation may be required.

3.3 Identify Inputs to the Decision

Decisions will be based on the data received from a combination of surveying and sampling events, including, but not limited to, field surveys and analytical laboratory results. The objective of the survey and sampling activities are to identify the concentrations of residual radioactive material in the survey units. This information will allow determination of whether or not a survey unit is likely to be suitable for release. The average soil concentrations will be evaluated to verify that the radiological cleanup criteria are met. Compliance will be demonstrated using:

- Systematic Soil Samples
- Biased Soil Samples
- Gamma Walkover Surveys
- Gamma Down-hole Surveys, if applicable
- Data Evaluation

3.4 Define the Study Boundaries

Data Population:
The data population of interest for the Site is the concentration of RCOCs and their associated comparison to the release criteria. A separate data population of concern is the activity concentration of RCOCs in the designated background reference area.

Spatial and Temporal Boundaries:
Survey units will subdivide the information geographically. The spatial boundaries of the project are horizontally limited to land areas located in the Site boundaries of Parcel A (including the Lounge Building footprint), Lower Parcel C, and footprints/work areas of the Dickson warehouse and Benbow building on Upper Parcel C. The vertical study area primarily includes surface soil over the vast majority of the Site. In pre-identified "exempt" areas, subsurface investigation may be performed to depths corresponding to historical limits of excavation. The study period begins with acceptance of this document and runs throughout the duration of FSS activities, culminating in the acceptance of Final Status Survey Reports by stakeholders.

Constraints on Data Collection:
Appropriate constraints will be placed on data collection to ensure high quality data is collected. All samples will be taken in accordance with the methodology identified in this FSSP, as well as applicable SEC procedures including a site-specific Field Sampling Plan.

3.5 Develop a Decision Rule

Parameter of Interest:
Parameters of interest are the mean, median, and standard deviation of data collected during the study. Nonparametric statistical tests will be utilized to determine whether or not the level of residual activity uniformly distributed throughout the survey unit exceeds the cleanup criteria. Since these methods are based on ranks, the results are generally expressed in terms of the

median. In some cases, the mean may exceed the median. For this reason, the arithmetic mean of the survey unit data will also be compared to the cleanup criteria as a first step in the interpretation of the data. By using a graded approach to data testing as discussed below, decisions will be made according to the decision rule stated at the end of this discussion.

Scale of Decision Making:
Decisions are made on two fundamental scales: the survey unit, and smaller localized areas of elevated activity. Localized areas of elevated radiation levels are evaluated on an ongoing basis throughout the field effort. In cases where clear indications of elevated measurements are observed, decisions on remediation, survey unit subdivision, etc., may be made as appropriate. On a larger scale, and as a final determination, data will be evaluated on a survey-unit specific basis. For localized areas with radioactive concentrations above the cleanup criteria, an elevated measurement comparison (EMC) will be performed.

Action Level:
Decisions on a survey unit's acceptability are based on a comparison of the measured residual radioactivity concentrations in survey units and the background, subject to applicable statistical analyses specified in MARSSIM. The action level corresponds to the established cleanup criteria.

Decision Inputs:
Scanning and analytical results (gamma spectroscopy) will be used to evaluate the effectiveness of remedial activities. Results will be compared to soil cleanup criteria discussed in **Section 2.2**. Determination of whether or not RCOC concentrations exceed background concentrations by more than the cleanup criteria will be made using all collected data and a strict statistical methodology. If the survey unit does not meet the cleanup criteria, further investigation is warranted. This application of decision rules or investigation levels may prompt collection of additional samples, further remediation, or reclassification of the survey unit. If the survey unit meets the cleanup criteria, no further remediation will be required.

Decision Rule:

1. Compare the survey unit data directly to the cleanup criteria:
    a. If all individual systematic and bias samples results are below the cleanup criteria, after background subtraction, then the survey unit passes and no further evaluation is necessary.
    b. If any single measurement is above cleanup criteria, after background subtraction, then further evaluation needed; proceed to Step 2.
2. Perform the statistical tests:
    a. Perform the WRS Test:
        i. If any systematic sample results are above the cleanup criteria, after background subtraction, then perform the WRS Test as detailed in **Section 4.4**. Passing the WRS Test is a strong indication that the survey unit may pass.
    b. Perform the EMC Test:
        i. If any sample result (systematic or bias) is above the cleanup criteria, after background subtraction, then perform the EMC test as detailed in **Section 4.4**. Passing the EMC Test is a strong indication that the survey unit may pass.

3. Perform a retrospective sample frequency evaluation:
    a. A retrospective sample frequency evaluation looks at the known variability of the systematic data set (as opposed to the *a priori* variability generated from the characterization data) to determine if enough samples were collected to provide sufficient statistical strength.

Note that the retrospective sample frequency evaluation is only used as an indication of confidence in the outcome(s) of the tests performed in Steps 1 and 2. If it is determined that a sufficient number of samples were collected then confidence in the outcome is high. However, in no way does a determination that an insufficient number of samples were collected indicate that a survey unit fails; in this case, professional judgment is required to evaluate all available data and determine a proper course of action.

3.6 Define Acceptable Limits on Decision Errors

The decisions necessary to determine compliance with the soil cleanup criteria are based on precise statistical statements called hypotheses. These hypotheses will be tested using data from a survey unit. The state that is presumed to exist is expressed as the null hypothesis (H_0). For a given Null Hypothesis, there is a specified Alternative Hypothesis (H_a) that is an expression of what is believed to be the state of reality if the null hypothesis is not true.

Null and Alternative Hypotheses:
The hypotheses selected for the FSS are as follows:

Null Hypothesis (H_0):
The median concentration in the survey unit exceeds the median concentration in the reference area by more than the cleanup criteria.

Versus:

Alternative Hypothesis (H_a):
The median concentration in the survey unit does not exceed the median concentration in the reference area by more than the cleanup criteria.

These hypotheses were chosen because the burden of proof is on the Null Hypothesis. Therefore, the survey unit will not be released until proven to meet the cleanup criteria. The measured median concentration in the survey unit must be less than the cleanup criteria in order to pass.

These hypotheses also were chosen because contamination below the cleanup criteria is measurable. Releasing a survey unit that requires additional remediation is an unacceptable alternative.

Statistically based decisions will be utilized for evaluating the release criteria. Statistical acceptability decisions, however, are always subject to error. Two possible error types are associated with such decisions. These are discussed below and summarized in **Table 3-1**.

Table 3-1: Hypothesis Testing and Consequences of Errors

		Survey Unit Decision	
	Hypothesis	*"Success"* (Reject H_O)	*"Failure"* (Accept H_O)
"True" Condition of the Survey Unit	**H_A** Meets remedial objective (e.g., at or below cleanup criterion)	No decision error (probability = 1 - α)	Incorrectly fail to release survey unit (Type II error with probability = β)
	H_O Exceeds remedial objective (e.g., exceeds cleanup criterion)	Incorrectly release survey unit (Type I error with probability = α)	No decision error (probability = 1 - β)

The first type of decision error, called a Type I error, occurs when the null hypothesis (H_o) is rejected when it is actually true. A Type I error is sometimes called a 'false positive'. The probability of a Type I error is usually called "alpha" and is denoted by α. This error could result in higher potential doses to future site occupants than prescribed by the cleanup criterion. Therefore, for the purposes of this study, the maximum Type I error rate will be set to 0.05. This is considered acceptable due to the reasonably anticipated future land-use of the Property.

The second type of decision error, called a Type II error, occurs when the null hypothesis is not rejected when it is actually false. A Type II error is sometimes called a 'false negative'. The probability of a Type II error is usually called "beta" and is denoted by β. The power of a statistical test is defined as the probability of rejecting the null hypothesis when it is false. It is numerically equal to 1-β. Consequences of Type II errors include unnecessary remediation expense and project delays. For the purposes of this study, the maximum Type II error rate will be β=0.05.

Relative Shift:
The lower boundary of the gray region (LBGR) and the target values for α and β are selected during the DQO process. For FSS planning purposes at the Site, and in accordance with MARSSIM, the LBGR is set to one-half the cleanup criteria. The width of the gray region (DCGL - LBGR), is a parameter that is central to the Wilcoxon Rank Sum (WRS) test. This parameter also is referred to as the shift, Δ. The absolute size of the shift is actually of less importance than the relative shift Δ/σ, where σ is an estimate of the standard deviation of the measured values in the survey unit. For planning purposes, the estimate of σ was based on the Characterization Data (see **Section 2.4**). For data evaluation purposes, the actual σ of the systematic data set is applied. The relative shift, Δ/σ, is an expression of the resolution of the measurements in terms of measurement uncertainty. The value of the relative shift is used to calculate the number of samples required to demonstrate that a survey unit has met the applicable release criteria.

3.7 Optimizing the Design

The variability of data will have an effect on the sampling design. If necessary, the sample frequency and the analytical procedures will undergo changes to optimize the design. Changes

will occur concurrently for several steps within the DQO process. The design options, such as sample collection design, sample size, and analytical procedures will be evaluated based on cost and the ability to meet the DQOs. The number of measurement and sample locations are addressed in **Section 4.0**. This FSS design follows the framework for design outlined in Sections 4 and 5 of MARSSIM (EPA, 2000).

4.0 FINAL STATUS SURVEY DESIGN

This section provides a detailed overview of the additional design components, which are based on those established in **Section 2.0** (HSA, background reference activity, estimated data variability – sigma, and cleanup criteria) and in **Section 3.0** (DQOs including hypothesis testing and acceptable error rates). Additional components include:

- Survey unit classification (based on the HSA)
- Numbers and locations of discrete samples (based on characterization σ)
- Gamma scanning parameters
- Data evaluation techniques including:
    - Interpretation of survey results
    - Wilcoxon-Rank Sum evaluation (WRS Test)
    - Elevated measurement comparison test (EMC Test)
    - Retrospective statistical strength evaluation.

4.1 Survey Unit Classification

Prior investigations, remedial efforts, FSSs, and a recent HSA have been performed on the Site and have been used as the basis for the initial determination of the area classifications established in this section. The historic Site data and the HSA were used to determine the current radiological status of the Site. Area classification decisions are made relative to the cleanup criteria as follows:

- **Class 1** areas are known or expected to have radionuclide concentrations above the cleanup criteria.
- **Class 2** areas are known or expected to have radionuclide concentrations above normal background concentrations but that are not expected to be above the cleanup criteria.
- **Class 3** areas are not expected to contain any residual radioactivity, or only contain levels that are a small fraction of the cleanup criteria.

As relates to pertinent areas of the Site addressed in this FSSP (Parcel A, Lower Parcel C, and building footprints), all areas were appropriately classified as "Class 2" in accordance with the above MARSSIM definitions and the *Class 2 Justification Memorandum* (SEC, 2014b).

The recommended conditions for demonstrating compliance based on a Class 2 survey unit designation (MARSSIM Table 2.2) includes: systematic sampling (discrete samples), performing gamma scans over 10- to 100- percent of the survey unit, statistical testing (WRS Test), and EMC evaluations. These parameters are discussed in greater detail through the remainder of this Section.

4.1.1 Reassignment of Survey Unit Classification

The initial area classifications are based on a combination of available data and historical information. Additional information obtained during the implementation of the FSSP may lead to the determination that the initial classifications established in **Section 4.1** should be revised to be consistent with the definitions (also given in **Section 4.1**). Each survey area classification change

will be recorded as an FSSP variation and will be documented and may require approval by stakeholders prior to implementation.

In general, any area classification may be upgraded to a more restrictive final survey protocol (e.g., from Class 2 to Class 1) upon receipt of additional survey or measurement information that justifies the need for the higher classification. Stakeholders will be notified and contractual agreements will be made prior to upgrading survey unit classification.

Downgrading an area classification to a less restrictive final survey protocol (e.g., from Class 2 to Class 3) is not expected, but would require regulatory approval prior to implementation.

4.1.2 Survey Unit Size

MARSSIM recommends the maximum size for a Class 2 survey unit be limited to 10,000 square meters (m^2). This FSSP intends to conform to this recommendation. However, in cases where logistical considerations and/or survey results indicate a need to modify the design, and where those modifications would otherwise result in a small orphaned area, additional area may be added to an existing survey unit provided that the original systematic grid spacing (see Section 4.2) is maintained and extended into the additional area. This translates to collecting more samples within that survey unit, commensurate with the amount of additional area. It is not anticipated that exceeding the recommended survey unit size will occur during implementation of the FSSP.

4.2 Number of Samples per Survey Unit

The number of samples required for the WRS test is ultimately driven by the variability of the data set, the residual concentration of RCOCs relative to the cleanup criteria, and the acceptable decision error rates. The evaluation is made specific to each cleanup criterion and the most restrictive sampling requirement is applied. **Table 4-1** summarizes the *a priori* evaluation used to determine the number of samples required per survey unit. After data is collected and evaluated, a retrospective evaluation is performed to confirm that sufficient measurements were collected to support release decisions.

Table 4-1: Sample Location Requirements per Survey Unit

Sample Location (N/2) Requirement Evaluation	Class 2 Survey Units	
	Ra-226 + Ra-228	Th-230 + Th-232
Parameter	**Value**	**Value**
Cleanup Criteria:	5.0 pCi/g	5.0 pCi/g
Lower Bound of Gray Region (LBGR): *a priori* value equal to 1/2 cleanup criteria	2.5 pCi/g	2.5 pCi/g
Shift Δ: (Cleanup Criteria – LBGR)	2.5 pCi/g	2.5 pCi/g
Estimated Standard Deviation σ: (σ from 2014 Investigation – 28 data points)	0.87 pCi/g	0.43 pCi/g
Relative Shift (Δ/σ):	2.84	6.44
Probability Function Pr: (From MARSSIM Table 5.1, using the relative shift above)	0.974067	1.000000
Estimated Minimum Number of Discrete Sample Locations (N/2): (Using MARSSIM Table 5.3, alpha and beta = 0.05)	10	9

Based on the N/2 evaluation presented in **Table 4-1**, a minimum of 10 samples will be collected from each Class 2 survey unit as driven by the Ra-226 + Ra-228 criterion. Note that this minimum requirement includes an additional 20 percent to account for potentially lost or unusable data in accordance MARSSIM.

4.2.1 Locating Discrete Samples

The results of discrete soil sampling will be used to verify that the soil concentrations are less than the acceptance criteria. A predetermined minimum number of samples will be collected in each survey unit based on the evaluation presented in **Table 4-1**. A random-start triangular pattern, or grid (generally the most efficient means of identifying small areas of elevated activity as opposed to a square grid), will be used in each survey unit to locate the soil samples. The triangular grid has approximately a 90 percent chance of detecting a circular hot spot of radius equal to one-half the grid spacing. The spacing of this systematic grid would be:

$$L = \sqrt{\frac{A}{0.866(N)}} \quad (1)$$

Where:

L = triangular grid spacing for survey unit (m)
A = area of survey unit (m^2)
N = number of sample locations

For a 10,000 m^2 survey unit that consisted of 10 sample locations, *L* would be equal to 33.98 meters. This value of *L* would actually remain constant for all survey units greater than 10,000 m^2 (larger survey units are not anticipated during implementation of the FSSP). For survey units less than 10,000 m^2, the grid spacing will be reduced to meet the *a priori* minimum sampling requirement of 10 sample locations.

The routine method of random sampling described above presumes that the actual scan MDC is less than or equal to the required scan MDC, i.e., that there is sufficient scan sensitivity available to detect small areas of elevated activity. Based on a review of historical site data, the established cleanup criteria and the *a priori* scan-MDC evaluation (see **Section 4.3**), gamma scans can be used effectively at the Site to identify areas that require further investigation. For areas that require additional investigation, discrete bias samples may also be collected in addition to the systematic samples.

The systematic grid will be randomly distributed for each survey unit. The random start point (X and Y coordinates) will be selected using a readily available random number generator such as the "RAND()" function in the Microsoft computer application Excel© (or the Visual Sample Plan computer application), or the methodology outlined in Section 5.5.2.5 of MARSSIM. Sample points will be identified in the field by flags or other means using a global positioning system (or equivalent locating tool) to spot each grid node. Beginning at the random starting point, a row of measurement locations or points is identified parallel to the X axis at intervals of L. For a triangular grid, a second row of points is then developed parallel to the first row, and off-set at a distance of 0.866 x L from the first row. To ensure a sufficient number of data points are obtained for statistical purposes, the value of L should be rounded down to the nearest whole meter (m) that can be easily measured in the field. If a point falls outside the survey unit or at locations that cannot be surveyed, additional points may be determined using a random selection process. **Table 4-2** presents examples of grid spacing for various survey unit sizes. The size of the "Hot Spot" reflects that area that may be missed by the random sampling grid, these areas are addressed through scanning (see **Section 4.3**).

Table 4-2: Example FSS Land Area Sample Collection Density

Area *A* (m^2)	No. of Samples (*N*)	Distance between Grid Nodes *L* (m)	Size of "Hot Spot" (m^2)
5,000	10	24.03	453.52
7,500	10	29.43	680.25
8,000	10	30.39	725.36
9,000	10	32.24	816.36
10,000 +	10	33.98	906.85

To ensure a sufficient number of data points are obtained for statistical purposes, the value of L is rounded down to the nearest whole meter which is easily measured in the field. If a point falls outside the survey unit or at locations that cannot be surveyed, additional points may be determined using a random selection process. Survey unit-specific grid spacing will be calculated for each survey unit after actual sizes are determined from field surveys.

4.2.2 Bias Samples

A bias sample is a sample, either surface or subsurface, whose location has been intentionally selected to target areas of concern based on either the results of the gamma surveys or due to historical areas of concern identified during the HSA.

Initially, based on regulator comments and the preliminary HSA results, there were six (6) areas that were identified as potential subsurface investigation areas. However, during subsequent HSA activities, it was determined that the areas of concern were either fully remediated in 2001, or were subsequently remediated in 2003 to meet the 2005 ESD criteria (SEC, 2014b).

During the course of FSS activities, based on gamma scan results and/or stakeholder direction, surface and/or subsurface bias samples may be collected. Bias samples results will be compared directly to the cleanup criteria to establish compliance (i.e., the are not evaluated using the WRS test). Elevated bias sample results may be subject to EMC testing, in which case additional samples may be collected to bound the area of elevated activity and to assign area factors in accordance with MARSSIM (see **Section 4.4**).

Bias areas identified by either gamma scanning or by historical areas of concern will be adequately investigated to ensure that the activity and extent of the areas are known.

4.3 Gamma Walkover Surveys

Gamma Walkover Survey (GWS) scans are performed to identify isolated areas of elevated radioactivity that may not be detected by discrete soil sampling (i.e., confirm that radiological conditions in each survey unit are reasonably uniform). GWS scans of the soil surfaces within survey units are performed using a Differential Global Positioning System (DGPS) coupled to a Ludlum Model 44-10 2-inch by 2-inch sodium iodide (2x2 NaI) detector with a Ludlum Model 2221 scaler/ratemeter. The GWS will be performed following a MARSSIM protocol by scanning straight lines at a rate of approximately 0.5 meters per second while moving the detector in a serpentine motion of approximately one meter wide and a consistent distance from the soil surfaces. GWS data in gross counts per minute (cpm) from the ratemeter/scaler will automatically be logged into the DGPS handheld unit at a rate of once per second.

4.3.1 Minimum Land Area Scan Coverage

MARSSIM recommends that the minimum land area scan coverage for a Class 2 survey unit be between 10 and 100 percent. For the purposes of this FSS design, GWS will to the extent possible, be performed over 100 percent of all accessible areas within each survey unit. This is equivalent to the scan coverage requirement for a Class 1 survey and is considered appropriate for this FSS effort.

4.3.2 Scan Minimum Detectable Concentration

Scan Minimum Detectable Concentration (Scan-MDC, or MDC_{scan}) is a parameter of central importance to a MARSSIM survey. The ability to effectively detect small, localized areas of elevated activity that may be missed during the collection of random systematic sample locations

is necessary to ensure that all areas of a survey unit are adequately investigated and allows for greater confidence in the outcome of the statistical tests.

Field instrument use will be evaluated and controlled to verify that MDCs less than the appropriate limit for scanning measurements are routinely achieved. Implementation of these MDC requirements is discussed below. The MARSSIM framework for determining the MDC for field instrument scanning activities is based on the premise that there are two stages of scanning. That is, surveyors do not make decisions on the basis of a single indication; rather, upon noting an increased number of counts, they pause briefly and then decide whether to move on or take further measurements. Thus, scanning consists of two components: continuous monitoring and stationary sampling. Accordingly, field instrument surveyor scan MDCs, minimum detectable count rate-surveyor ($MDCR_S$), are calculated to control the occurrence of Type I (false positive) and Type II (false negative) errors using the following MARSSIM equation:

$$MDCR_S = \frac{MDCR}{\sqrt{p}\varepsilon} \tag{2}$$

Where MDCR is the minimum detectable count rate [counts per minute (cpm)], p is the surveyor efficiency (estimated in MARSSIM to be between 0.5 and 0.75; the value of 0.5 results in a more conservative $MDCR_S$ calculation and, therefore, will be used), and ε is the instrument efficiency (cpm per μR/hr; Table 6.4, NRC 1998). In addition:

$$MDCR = s_i\left(\frac{60}{i}\right) \tag{3}$$

Where:

$$s_i = d'\sqrt{b_i} \tag{4}$$

Where s_i (counts) is the minimal number of net source counts required for a specified level of performance for the counting interval i (seconds); d' is the index of sensitivity; and b_i is the number of background counts in the interval. Index of sensitivity d' values are listed in MARSSIM Table 6.5 based on the proportions for required true positive and tolerable false positive occurrence rates. The index of sensitivity value selected for initial use at the Site is 1.38, corresponding to a true positive proportion of 0.95 and a false positive proportion of 0.60. While this index of sensitivity value will result in at least 95 percent "correct" scanning detections as required by the Site DQO for Type I error control, up to 60 percent "incorrect" (false positive) scanning detections may occur. For the purpose of this survey, the high rate of false positives is considered appropriate to ensure that an adequate investigation is performed. However, should this become an intolerable compromise, a larger index of sensitivity value corresponding to the 0.95 true positive proportion may instead be used provided the required scan MDC is achieved.

Calculated scan MDCs for a survey instrument equipped with 2x2 NaI scintillation detector using the MARSSIM two-stage scanning framework are summarized for a 15 cm thick contamination layer of Ra-226 and Th-232 in **Table 4-3** below.

Table 4-3: 2x2 NaI Scintillation Dector Scan-MDCs

Radionuclide	Scan MDC (pCi/g)[a]	Single Radionuclide Cleanup Criteria (pCi/g)[b]
Ra-226[c]	2.0	2.5
Th-232[c]	1.3	2.5

[a] Background level assumed to be 5,000 cpm (conservative based on recent survey data).
[b] Set to one-half the combination of Ra-226+Ra-228 and Th-230+Th-232, respectively.
[c] In equilibrium with progeny.

As shown in **Table 4-3**, the Scan-MDC for Ra-226 and Th-232 are comfortably below their respective DCGL values. Scan-MDCs using a 2x2 NaI detector and the scanning technique described above are expected to be significantly lower. Additionally, the absence of strong gamma emissions from Ra-228 and Th-230 is accounted for by reducing the "Single Radionuclide Cleanup Criteria" by one-half of the combined cleanup criteria (5.0 pCi/g).

4.4 Interpretation of Survey Results

The initial evaluation of survey results will determine compliance for each survey unit by comparing survey unit statistics (mean, and/or median, and maximum) against the cleanup criteria. **Table 4-4**, reproduced from MARSSIM, illustrates the intended conclusions relative to the data set.

Table 4-4: Initial Survey Unit Evaluation Conclusions

Survey Result	Conclusion
If the difference between maximum survey unit result and the minimum reference area result is less than the cleanup criteria, then:	The survey unit meets release criterion.
If the difference of the survey unit results average and the reference area results average is greater than the cleanup criteria, then:	The survey unit does not meet release criterion.
If the difference between any survey unit result and any reference area result is greater than the cleanup criteria, and the difference of the survey unit average and reference area average is less than cleanup criteria, then:	Conduct the following Wilcoxon Rank Sum (WRS) Test and Elevated Measurement Comparison (EMC) if necessary, to determine if the unit meets release criterion.

Therefore, if all results (Ra-226 + Ra-228, and Th-230 + Th-232, evaluated independently) after background subtraction are below their respective cleanup criterion, then the survey unit satisfies cleanup criteria and no further evaluation is warranted (i.e., WRS test and EMC test are not required).

If the average of the respective results, after background subtraction, is greater than their respective cleanup criterion, then the survey unit will be deemed to have failed and additional investigations and/or remediation should be considered.

If any single measurement exceeds their respective cleanup criterion, then further evaluation via WRS testing and EMC evaluation shall be performed as described in the following sections.

4.4.1 WRS and EMC Testing

The WRS test discussed in this section may also be used to compare each survey unit with the reference area. This test was chosen because contamination is present in the background at the Site.

The comparison of measurements from a reference area to the survey unit is made using the WRS test (MARSSIM [EPA, 2000]). The WRS test is effective when residual radioactivity is uniformly present throughout a survey unit (i.e., the sample distribution is symmetrical). The test is designed to detect whether or not activity exceeds the cleanup criteria.

The Null Hypothesis is assumed to be true unless the statistical test indicates that it should be rejected in favor of the alternative. It is assumed that any difference between the reference area and survey unit concentration distributions is due to a shift in the survey unit concentrations to higher values (i.e. due to the presence of residual radioactivity in addition to background that exceeds cleanup criteria). Survey units may meet the release criteria even though some measurements may be greater than some reference area measurements. Also, survey unit measurements may exceed some reference area measurements by more than the cleanup criteria. The result of the hypothesis test determines whether or not the survey unit as a whole meets the release criterion.

Two underlying assumptions of the WRS test are:

- Samples from the reference area and survey unit are independent, identically distributed random samples; and
- Each measurement is independent of every other measurement, regardless of the set of samples from which it came.

If all of the sample results are less than the cleanup criteria then no WRS statistical evaluation is required.

4.4.1.1 Performing the Wilcoxon Rank Sum Test

The WRS test is applied as outlined in the following six steps by MARSSIM (EPA, 2000):

Step 1

Obtain the adjusted reference area measurements, Z_i, by adding the $DCGL_W$ to each reference area measurement, X_i. $Z_i = X_i$ + cleanup criterion.

Step 2

The *m* adjusted reference sample measurements, Z_I, from the reference area and the *n* sample measurements, Y_I, from the survey unit are pooled and ranked in order of increasing size from 1 to N, where $N = m + n$.

Step 3

If several measurements are tied (i.e., have the same value), they are all assigned the average rank of that group of tied measurements.

Step 4

If there are *t* less than (<) the decision level (L_c) values, they are all given the average of the ranks from 1 to *t*. Therefore, they are all assigned the rank $t(t+1)/2t = (t+1)/2$, which is the average of the first *t* integers. If there is more than one detection limit, all observations below the largest detection limit should be treated as < values.

Step 5

Sum the ranks of the adjusted measurements from the reference area, W_r. Note that since the sum of the first N integers is N(N+1)/2, one can equivalently sum the ranks of the measurements from the survey unit, W_s, and compute $W_r = N(N+1)/2 - W_s$.

Step 6

Compare W_r with the critical value given in MARSSIM Table I.4, Critical Values for the WRS Test, for the appropriate values of *n*, *m*, and □. If W_r is greater than the tabulated value, reject the Null Hypothesis that the survey unit exceeds the release criterion. The standard deviation of the sample set is then calculated to establish the relative shift of the test. The relative shift is used to investigate whether or not the survey unit has the proper number of samples.

4.4.1.2 Elevated Measurement Comparison

Both the measurements at discrete locations and the scans may be used to identify elevated areas within a survey unit. Analytical results of soil samples may be used to complete the elevated measurement comparison. If residual radioactivity is found in a localized area of elevated activity—in addition to the residual radioactivity distributed relatively uniformly across the survey unit−the Unity Rule discussed above shall be used to ensure that the release criterion has been met as follows:

$$\frac{\delta}{DCGL} + \sum_{x+1}^{n} \frac{(\delta_{EMC} - \delta)}{DCGL_{EMC}} \leq 1 \qquad (5)$$

where:

δ = the average concentration of Ra-226+Ra-228, or Th-230+Th-232 over the entire survey unit,

δ_{EMC} = the average concentration of Ra-226+Ra-228, or Th-230+Th-232 over the elevated area x within the survey unit,

DCGL = appropriate Ra-226+Ra-228, or Th-230+Th-232 cleanup criterion value,

$DCGL_{EMC}$ = (area factor for elevated area x) X (cleanup criterion value),

x = refers to one of the elevated areas within the survey unit, and

n = the total number of elevated areas within the survey unit.

If there is more than one elevated area, a separate term shall be included for each area. The result of the EMC shall be used as a trigger for further investigation. The investigation may involve taking further measurements to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion. The investigation shall provide adequate assurance, using the DQO process, that there are no other undiscovered areas of elevated residual radioactivity in the survey unit that might otherwise result in an exceedance of the release criterion. In some cases, this may lead to reclassifying a survey unit; unless the results of the investigation indicate that reclassification is not necessary.

4.5 Anticipated Breakdown of FSS Activities

The entirety of Parcel A will be subject to a Class 2 Survey. Parcel A is approximately 28,000 m^2 in area; therefore, three (3) Class 2 survey units are planned, each with a nominal size of approximately 9,500 m^2. Each survey unit will be subject to a 100 percent GWS of all accessible areas. Each survey unit will require a minimum of 10 systematic samples, collected from a triangular systematic grid established from a random staring point. All systematic samples will be collected from the surface. Additionally, Bias samples may be collected from areas corresponding to the historic footprint of the Lounge Building, as well as the historic EPA "exempt areas". Bias sampling may involve subsurface samples collected via geoprobe.

The entirety of Lower Parcel C will be subject to a Class 2 survey. Lower Parcel C is approximately 9,000 m^2 and will be subject to a single FSS as described above. Additional bias locations within Lower Parcel C, which correspond to historic EPA "exempt" areas may be subject subsurface bias sampling as described above.

The areas of concern for Upper Parcel C are limited to the historic footprints of the Dickson Warehouse and the Benbow Building. Each building footprint will represent the extent of an individual Class 2 survey unit which will be implemented as described above. Additionally, surface scanning immediately adjacent to the building footprints will be performed to ensure that recent demolition activities did not spread contamination.

No FSS is recommended or necessary for Parcel B, based on prior FSS within the Parcel and the absence of activity since the FSS was performed.

Table 4-5: Anticipated Site-wide FSS Activity Summary

Location	Total Survey Units	Total Systematic Samples[1]	Possible Bias Locations[1,2]	10% QC Samples[1]	Total Samples[1]
Parcel A	3	30	4	4	38
Parcel B	0	0	0	0	0
Lower C	1	10	2	2	14
Dickson	1	10	1	2	13
Benbow	1	10	1	2	13
Totals:	6	60	8	10	78

[1] Estimated numbers required in accordance with this FSSP, actual numbers may increase or decrease.
[2] Bias locations may increase or decrease based on survey results and stakeholder direction regarding historical exempt areas.

Figure 4-1 provides an example of potential survey units on the site.

Figure 4-1: Idealized Survey Unit Layout Example

5.0 SURVEY INSTRUMENTATION AND MEASUREMENT TECHNIQUES

This section presents a description of radiological field instrumentation and laboratory measurements that will be used during implementation of this FSSP.

5.1 Land Areas Survey Instrumentation

Prior to the initiation of FSS activities, a 2x2 NaI scintillation detector will be used to develop an MDC and investigation level for gamma scanning of soils. The *a priori* Scan-MDC evaluation was presented in **Section 4.3.2**.

5.1.1 Detection Sensitivity Requirements

Field instrument use will be evaluated and controlled to verify that MDCs less than the appropriate cleanup criteria for scanning measurements are routinely achieved. Implementation of these MDC requirements was discussed in **Section 4.3.2**.

5.2 Laboratory Analysis

An independent, off-site, Environmental Laboratory Approval Program (ELAP)-certified laboratory, will perform radiological analysis of FSS soil samples. The selected radiochemistry laboratory shall be capable of providing the analytical services required to meet the project DQOs.

Table 5-1 contains a list of gamma and x-ray emissions from the site radiological COCs that may used for determining soil activity concentrations.

Table 5-1: Spectroscopic Gamma Energy Lines and Minimum Detectable Concentrations for Site RCOCs

Radiological COC	Direct / Inferred	Inferred Radionuclide	Photon Emission (keV), *primary	Yield (%)	Sample BEGe MDC (pCi/g)(a)
Th-232	Inferred	Pb-212	238.6	43.3	
		Ac-228	*911.2	25.8	0.25
Th-230	Inferred	Ra-226	*186.2	3.59	0.5 – 2.5
Ra-226	Direct	Ra-226	*186.2	3.59	0.5 – 2.5
	Inferred	Bi-214	609.3 1120.3 1764.5	46.3 14.9 15.8	0.05
		Pb-214	242.0 295.2 351.9	7.3 18.4 35.6	0.04
Ra-228	Inferred	Ac-228	*911.2	25.8	0.25

(a) The nuclide MDC values stated in the table are from a 1,500 gram sugar background sample in a Marinelli beaker counted for 20 minutes on a 60% detector inside a lead cave. Actual Site MDCs will vary depending upon detector characteristics, count time, geometry, and activity content of samples.

FSS soil samples will be analyzed off-site for the nuclides of concern via gamma spectroscopy. Ra-226 will be analyzed by gamma spectroscopy after progeny ingrowth (Pb-214 or Bi-214) within a sealed counting container.

6.0 QUALITY ASSURANCE PROGRAM

The objective of a QA program is to identify and implement sampling and analytical methodologies that limit the introduction of error into analytical data. In general, field QA/QC shall be in accordance with established implementing procedures used to implement this FSSP. Laboratory QA/QC responsibilities will rest with the ELAP accredited laboratory, American Radiation Services (ARS) located in Port Allen, LA.

6.1 FSSP Performance Assessment

On-going assessments and surveillances of FSSP implementation will be conducted in accordance with SEC field sampling plan requirements. Corrective actions resulting from observations shall be promptly implemented. Surveillances (work practice observations) will be informal routine occurrences at the Site, and will be performed by a SEC senior field crew member. The surveillance objective is twofold: (1) verify FSSP requirements are being anticipated and implemented correctly, and (2) identify improvements in work practices improving project efficiency. Supervisory project personnel will be responsible for the effectiveness of the surveillance portion of FSSP performance assessment.

6.2 Field Instrumentation

For all counting systems and instruments used as part of analytical analyses, at a minimum, the following QC principles will be applied.

6.2.1 Procedures

Counting systems and instruments will be used in accordance with approved SEC implementing procedures.

6.2.2 Source and Instrument Checks

Each day that a portable counting system and instrument are used, the system's response will be checked using an appropriate source prior to use at the start of a shift and also following use at the end of a shift. Additional response checks may be necessary depending on the counting system used. In addition:

- For field instrumentation, source check acceptance criteria (e.g., $\pm 2\ \sigma$ for direct [integrated] measurements and ±20 percent for rate measurements) will be established prior to beginning the project.
- All source check results will be documented.
- Failed source checks will be repeated. Consecutive failure will result in additional testing of the counting system, in accordance with the applicable procedure, and ultimately removing the counting system from service.
- Survey data acquired prior to an instrument failing a source check will be reviewed and documented by the Data Manager to determine the validity of the data.
- All instrument failures in the field will be followed by a documented investigation of suspect data.

6.2.3 Background Determination

When FSS activities are conducted, the ambient background will be determined and documented at least once daily per instrument, depending on the instrument used and the variability in the background.

6.2.4 Calibration

All counting systems and instruments will be calibrated with a National Institute of Standards and Technology (NIST)-traceable source at intervals not exceeding 12 months, or as recommended by the manufacturer for portable field survey instruments. The source used will be appropriate for the type and the energy of the radiation to be detected. All calibrations will be documented and include the source data.

6.3 Sample Collection

Soil sampling will be performed in accordance with the Site-specific SAP (SEC 2014d).

6.4 Analytical Laboratory Services

Radiological analytical services provided by each laboratory will be provided in accordance with their internal laboratory QAP (LQAP) implemented by documented policies and procedures. The Data Manager shall confirm that the management objectives of the LQAP, policies, and procedures are to produce data that are scientifically valid, defensible, and of known and documented quality. The Data Manager shall be cognizant of the nature and extent of each laboratory's LQAP and establish a notification protocol with the laboratory should the laboratory QC officer identify LQAP deviations adversely affecting results for the Site.

6.4.1 Laboratory Analysis Specifications

For each laboratory analysis requested, the following minimum specifications will be provided to the laboratory on the appropriate CoC record:

- Required analyses and/or analytical methodology,
- Nonstandard results presentation requirements,
- Sample disposition (disposed or archived), and
- Turnaround time required.

6.4.2 Laboratory Quality Assurance/Quality Control

The contract laboratory shall be ELAP certified and compliant. Data packages shall indicate the laboratories QA/QC qualifications and/or deficiencies.

7.0 DATA PACKAGES AND DELIVERABLES

Each survey unit will be evaluated in accordance with MARSSIM, and recommendations regarding the release of the survey unit, based upon satisfaction of cleanup criteria, will be made. The entire data set, and all evaluations used to arrive at conclusions and recommendation will be assembled and provided to all stakeholders. Information to be included in the final report(s) includes:

- Summary of FSS parameters (size, location, classification, sample totals)
- Analytical data, including laboratory data packages
- GWS data including plots of sample locations
- Down-hole gamma logging data, if applicable
- Data set statistics
- WRS Test results, if applicable
- EMC Evaluation results, if applicable
- Descriptions of any QA/QC issues encountered, if applicable
- Conclusions and Recommendations related to the release status of the survey unit and/or Parcel and/or Site.

8.0 REFERENCES

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SEC, 2014c. *Li Tungsten 2014 Quality Assurance Program Plan,* this document is still in development by Perma-Fix Environmental Services, Inc., Knoxville, TN.

SEC, 2014d. *Li Tungsten 2014 Sampling and Analysis Plan*, this document is still in development by Perma-Fix Environmental Services, Inc., Knoxville, TN.

PWG, 2014. *2014 Subsurface Investigation*, a collection of maps and analytical data generated during a 2014 investigation performed between January and February and available online at https://www.dropbox.com/sh/jspccbmhlrmgw2o/ffYEgtKTi4

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APPENDIX B

Off-Site Laboratory Results

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-02394

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
2800 Solway Road
Knoxville, TN 37931

jhubler@perma-fix.com
elaning@perma-fix.com; swalnicki@perma-fix.com

Phone: 865-690-0501

Project Manager Review

Management Review

Notes: ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

ACCREDITED DoD ELAP

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

October 8, 2014

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Project Number: **144036**

Dear Mr. Laning;

On September 8, 2014, ARS International received 38 solid samples to be analyzed for Gamma Spectroscopy and Isotopic Thorium.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

Eugene Mulligan

Laboratory Management
ARS International

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

PROJECT SAMPLE IDENTIFICATION CROSS-REFERENCE TO ARS SAMPLE LABORATORY IDs

Project Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
144036	FS-02-01	ARS1-14-02394-001
144036	FS-02-01D	ARS1-14-02394-002
144036	FS-02-02	ARS1-14-02394-003
144036	FS-02-03	ARS1-14-02394-004
144036	FS-02-04	ARS1-14-02394-005
144036	FS-02-06	ARS1-14-02394-006
144036	FS-02-08	ARS1-14-02394-007
144036	FS-03-01	ARS1-14-02394-008
144036	FS-03-01D	ARS1-14-02394-009
144036	FS-03-02	ARS1-14-02394-010
144036	FS-03-04	ARS1-14-02394-011
144036	FS-03-06	ARS1-14-02394-012
144036	FS-03-08	ARS1-14-02394-013
144036	FS-04-01	ARS1-14-02394-014
144036	FS-04-02	ARS1-14-02394-015
144036	FS-04-03	ARS1-14-02394-016
144036	FS-04-04	ARS1-14-02394-017
144036	FS-04-05	ARS1-14-02394-018
144036	FS-04-06	ARS1-14-02394-019

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PROJECT SAMPLE IDENTIFICATION
CROSS-REFERENCE
TO ARS SAMPLE LABORATORY IDs

Project Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
144036	FS-04-06D	ARS1-14-02394-020
144036	FS-04-07	ARS1-14-02394-021
144036	FS-04-08	ARS1-14-02394-022
144036	FS-04-09	ARS1-14-02394-023
144036	FS-04-10	ARS1-14-02394-024
144036	FS-05-01	ARS1-14-02394-025
144036	FS-05-02	ARS1-14-02394-026
144036	FS-05-04	ARS1-14-02394-027
144036	FS-05-05	ARS1-14-02394-028
144036	FS-05-06	ARS1-14-02394-029
144036	FS-05-07	ARS1-14-02394-030
144036	FS-05-08	ARS1-14-02394-031
144036	FS-05-08D	ARS1-14-02394-032
144036	FS-05-09	ARS1-14-02394-033
144036	FS-05-10	ARS1-14-02394-034
144036	HS-PA-D1	ARS1-14-02394-035
144036	HS-PA-D2	ARS1-14-02394-036
144036	HS-PA-D3	ARS1-14-02394-037
144036	HS-PA-D4	ARS1-14-02394-038

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ANALYTICAL METHODS

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

Thorium analyses were performed using **ARS-031, "Thorium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (ACW10)".**

ANALYTICAL RESULTS

The result data that are flagged with "U" indicate that the activity is below the MDC.

American Radiation Services Project Manager/Laboratory Director's Comments:
"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

Virginia Mulligan	Laboratory Management, ARS International	10-8-14
Signature	**Title**	**Date**

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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-02-01
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-001
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.926	1.390	0.367	0.184		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
BI-212	0.392	0.335	0.528	0.264	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
PB-212	0.699	0.133	0.120	0.060		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
BI-214	0.551	0.142	0.124	0.062		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
PB-214	0.513	0.107	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
RA-226	0.551	0.142	0.124	0.062		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
RA-228	0.439	0.132	0.223	0.112		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
AC-228	0.439	0.132	0.223	0.112		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
TH-232	0.439	0.132	0.223	0.112		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
U-235	0.100	0.221	0.377	0.189	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 08:45	JDT	NA
TH-228	0.767	0.172	0.053	0.017		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	38%
TH-230	0.518	0.131	0.037	0.009		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	38%
TH-232	0.484	0.127	0.050	0.016		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	38%

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself.*
Reproduction of this report in less than full requires the written consent of ARS International, LLC.
The results in this report pertain only to the samples tested and are intended solely for the use of the client.

LELAP Certificate# 01949

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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-02-01D
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-002
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.239	1.290	0.686	0.343		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA
BI-212	0.693	0.304	0.249	0.125		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA
PB-212	0.576	0.112	0.099	0.050		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA
BI-214	0.498	0.115	0.120	0.060		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA
PB-214	0.601	0.126	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA
RA-226	0.498	0.115	0.120	0.060		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA
RA-228	0.528	0.127	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA
AC-228	0.528	0.127	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA
TH-232	0.528	0.127	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA
U-235	0.084	0.162	0.276	0.138	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 08:46	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-02-02
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-003
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.225	1.526	0.526	0.263		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA
BI-212	0.151	0.350	0.624	0.312	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA
PB-212	0.561	0.138	0.136	0.068		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA
BI-214	0.527	0.151	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA
PB-214	0.546	0.130	0.147	0.074		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA
RA-226	0.527	0.151	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA
RA-228	0.730	0.206	0.148	0.074		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA
AC-228	0.730	0.206	0.148	0.074		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA
TH-232	0.730	0.206	0.148	0.074		pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA
U-235	0.149	0.250	0.423	0.212	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 08:47	JDT	NA

NOTES:

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1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-02-03
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-004
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.257	1.411	0.656	0.328		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA
BI-212	0.279	0.298	0.476	0.238	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA
PB-212	0.454	0.103	0.101	0.051		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA
BI-214	0.590	0.136	0.111	0.056		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA
PB-214	0.606	0.132	0.089	0.045		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA
RA-226	0.590	0.136	0.111	0.056		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA
RA-228	0.349	0.128	0.232	0.116		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA
AC-228	0.349	0.128	0.232	0.116		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA
TH-232	0.349	0.128	0.232	0.116		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA
U-235	-0.017	1.250	0.359	0.180	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:19	JDT	NA

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1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-02-04
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-005
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	8.164	1.251	0.376	0.188		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
BI-212	0.324	0.295	0.469	0.235	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
PB-212	0.608	0.111	0.094	0.047		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
BI-214	0.570	0.121	0.088	0.044		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
PB-214	0.597	0.125	0.105	0.053		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
RA-226	0.570	0.121	0.088	0.044		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
RA-228	0.392	0.148	0.248	0.124		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
AC-228	0.392	0.148	0.248	0.124		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
TH-232	0.392	0.148	0.248	0.124		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
U-235	-0.017	1.144	0.358	0.179	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA

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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-02-06
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-006
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	8.223	1.225	0.712	0.356		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
BI-212	0.092	0.277	0.490	0.245	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
PB-212	0.536	0.110	0.099	0.050		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
BI-214	0.470	0.111	0.111	0.056		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
PB-214	0.618	0.119	0.109	0.055		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
RA-226	0.470	0.111	0.111	0.056		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
RA-228	0.615	0.148	0.079	0.039		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
AC-228	0.615	0.148	0.079	0.039		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
TH-232	0.615	0.148	0.079	0.039		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA
U-235	-0.021	3.006	0.309	0.155	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:20	JDT	NA

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2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-02-08
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-007
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	7.614	1.221	0.404	0.202		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA
BI-212	0.211	0.244	0.405	0.203	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA
PB-212	0.431	0.097	0.090	0.045		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA
BI-214	0.372	0.113	0.139	0.070		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA
PB-214	0.426	0.104	0.139	0.070		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA
RA-226	0.372	0.113	0.139	0.070		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA
RA-228	0.439	0.150	0.201	0.101		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA
AC-228	0.439	0.150	0.201	0.101		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA
TH-232	0.439	0.150	0.201	0.101		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA
U-235	0.148	0.206	0.344	0.172	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:22	JDT	NA

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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-03-01
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-008
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	3.874	0.911	0.775	0.388		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA
BI-212	0.129	0.279	0.491	0.246	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA
PB-212	0.305	0.094	0.102	0.051		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA
BI-214	0.437	0.111	0.091	0.045		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA
PB-214	0.318	0.088	0.090	0.045		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA
RA-226	0.437	0.111	0.091	0.045		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA
RA-228	0.187	0.109	0.220	0.110	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA
AC-228	0.187	0.109	0.220	0.110	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA
TH-232	0.187	0.109	0.220	0.110	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA
U-235	-0.024	6.440	0.342	0.171	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:52	JDT	NA

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LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-03-01D
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-009
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	3.993	0.919	0.617	0.309		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA
BI-212	0.174	0.230	0.394	0.197	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA
PB-212	0.331	0.100	0.103	0.052		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA
BI-214	0.243	0.099	0.135	0.068		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA
PB-214	0.312	0.087	0.117	0.059		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA
RA-226	0.243	0.099	0.135	0.068		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA
RA-228	0.261	0.117	0.154	0.077		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA
AC-228	0.261	0.117	0.154	0.077		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA
TH-232	0.261	0.117	0.154	0.077		pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA
U-235	0.075	0.168	0.290	0.145	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 09:54	JDT	NA

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Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-03-02
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-010
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	5.440	1.080	0.776	0.388		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA
BI-212	0.303	0.335	0.541	0.271	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA
PB-212	0.616	0.121	0.106	0.053		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA
BI-214	0.282	0.108	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA
PB-214	0.545	0.116	0.117	0.059		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA
RA-226	0.282	0.108	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA
RA-228	0.606	0.139	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA
AC-228	0.606	0.139	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA
TH-232	0.606	0.139	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA
U-235	0.045	0.194	0.339	0.170	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 10:03	JDT	NA

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Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-03-04
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-011
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.401	1.400	0.631	0.316		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
BI-212	0.406	0.281	0.402	0.201		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
PB-212	0.575	0.114	0.098	0.049		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
BI-214	0.504	0.126	0.106	0.053		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
PB-214	0.595	0.124	0.088	0.044		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
RA-226	0.504	0.126	0.106	0.053		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
RA-228	0.492	0.136	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
AC-228	0.492	0.136	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
TH-232	0.492	0.136	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
U-235	0.012	0.190	0.336	0.168	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 10:35	JDT	NA
TH-228	0.602	0.127	0.013	0.000		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	63%
TH-230	0.538	0.117	0.045	0.017		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	63%
TH-232	0.568	0.122	0.045	0.017		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	63%

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2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-03-06
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-012
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	7.165	1.203	0.603	0.302		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA
BI-212	0.135	0.258	0.454	0.227	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA
PB-212	0.390	0.103	0.106	0.053		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA
BI-214	0.413	0.102	0.088	0.044		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA
PB-214	0.380	0.098	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA
RA-226	0.413	0.102	0.088	0.044		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA
RA-228	0.352	0.180	0.254	0.127		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA
AC-228	0.352	0.180	0.254	0.127		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA
TH-232	0.352	0.180	0.254	0.127		pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA
U-235	0.200	0.206	0.336	0.168	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 10:59	JDT	NA

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1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-03-08
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-013
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	8.878	1.338	0.748	0.374		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA
BI-212	0.489	0.293	0.418	0.209		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA
PB-212	0.706	0.130	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA
BI-214	0.454	0.120	0.126	0.063		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA
PB-214	0.617	0.130	0.124	0.062		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA
RA-226	0.454	0.120	0.126	0.063		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA
RA-228	0.686	0.151	0.145	0.073		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA
AC-228	0.686	0.151	0.145	0.073		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA
TH-232	0.686	0.151	0.145	0.073		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA
U-235	-0.098	0.333	0.353	0.177	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 11:02	JDT	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-01
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-014
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	6.463	1.063	0.785	0.393		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA
BI-212	0.157	0.241	0.407	0.204	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA
PB-212	0.524	0.110	0.097	0.048		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA
BI-214	0.446	0.101	0.102	0.051		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA
PB-214	0.401	0.093	0.115	0.058		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA
RA-226	0.446	0.101	0.102	0.051		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA
RA-228	0.509	0.137	0.073	0.036		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA
AC-228	0.509	0.137	0.073	0.036		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA
TH-232	0.509	0.137	0.073	0.036		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA
U-235	-0.113	0.249	0.312	0.156	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 11:03	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-02
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-015
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	5.921	1.248	1.090	0.545		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA
BI-212	0.070	0.377	0.678	0.339	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA
PB-212	0.456	0.106	0.110	0.055		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA
BI-214	0.305	0.140	0.212	0.106		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA
PB-214	0.427	0.129	0.189	0.095		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA
RA-226	0.305	0.140	0.212	0.106		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA
RA-228	0.455	0.166	0.287	0.144		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA
AC-228	0.455	0.166	0.287	0.144		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA
TH-232	0.455	0.166	0.287	0.144		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA
U-235	0.089	0.247	0.429	0.215	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 11:38	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-03
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-016
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	6.487	1.125	0.502	0.251		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA
BI-212	0.806	0.271	0.187	0.094		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA
PB-212	0.467	0.105	0.104	0.052		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA
BI-214	0.367	0.112	0.139	0.070		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA
PB-214	0.363	0.102	0.154	0.077		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA
RA-226	0.367	0.112	0.139	0.070		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA
RA-228	0.448	0.160	0.195	0.098		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA
AC-228	0.448	0.160	0.195	0.098		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA
TH-232	0.448	0.160	0.195	0.098		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA
U-235	0.151	0.192	0.318	0.159	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 11:31	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-04
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-017
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	6.210	1.586	1.400	0.700		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA
BI-212	-0.034	0.675	0.564	0.282	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA
PB-212	0.668	0.114	0.093	0.047		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA
BI-214	0.651	0.130	0.088	0.044		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA
PB-214	0.763	0.141	0.106	0.053		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA
RA-226	0.651	0.130	0.088	0.044		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA
RA-228	0.593	0.153	0.226	0.113		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA
AC-228	0.593	0.153	0.226	0.113		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA
TH-232	0.593	0.153	0.226	0.113		pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA
U-235	-0.090	0.323	0.358	0.179	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 11:47	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-05
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-018
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	8.587	1.434	0.822	0.411		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA
BI-212	0.330	0.307	0.477	0.239	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA
PB-212	0.495	0.113	0.101	0.051		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA
BI-214	0.279	0.108	0.145	0.073		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA
PB-214	0.700	0.156	0.131	0.066		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA
RA-226	0.279	0.108	0.145	0.073		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA
RA-228	0.435	0.157	0.223	0.112		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA
AC-228	0.435	0.157	0.223	0.112		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA
TH-232	0.435	0.157	0.223	0.112		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA
U-235	0.074	0.183	0.316	0.158	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:17	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-06
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-019
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	6.873	1.066	0.326	0.163		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA
BI-212	0.293	0.246	0.384	0.192	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA
PB-212	0.385	0.084	0.082	0.041		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA
BI-214	0.377	0.092	0.072	0.036		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA
PB-214	0.289	0.086	0.109	0.055		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA
RA-226	0.377	0.092	0.072	0.036		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA
RA-228	0.282	0.113	0.220	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA
AC-228	0.282	0.113	0.220	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA
TH-232	0.282	0.113	0.220	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA
U-235	-0.070	0.334	0.310	0.155	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:18	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-06D
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-020
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	5.553	0.972	0.830	0.415		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA
BI-212	0.231	0.245	0.395	0.198	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA
PB-212	0.473	0.090	0.078	0.039		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA
BI-214	0.348	0.094	0.104	0.052		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA
PB-214	0.353	0.087	0.095	0.048		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA
RA-226	0.348	0.094	0.104	0.052		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA
RA-228	0.359	0.108	0.185	0.093		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA
AC-228	0.359	0.108	0.185	0.093		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA
TH-232	0.359	0.108	0.185	0.093		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA
U-235	0.014	0.163	0.286	0.143	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:20	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-07
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-021
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	7.305	1.146	0.368	0.184		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
BI-212	0.299	0.274	0.436	0.218	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
PB-212	0.545	0.114	0.112	0.056		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
BI-214	0.444	0.096	0.072	0.036		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
PB-214	0.487	0.101	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
RA-226	0.444	0.096	0.072	0.036		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
RA-228	0.405	0.130	0.232	0.116		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
AC-228	0.405	0.130	0.232	0.116		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
TH-232	0.405	0.130	0.232	0.116		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
U-235	-0.109	0.352	0.421	0.211	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:47	JDT	NA
TH-228	0.600	0.124	0.030	0.009		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	63%
TH-230	0.477	0.109	0.060	0.024		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	63%
TH-232	0.625	0.127	0.043	0.016		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	63%

NOTES:

Project Manager Review

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LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-08
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-022
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	6.183	0.981	0.310	0.155		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA
BI-212	0.006	0.234	0.436	0.218	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA
PB-212	0.354	0.090	0.087	0.043		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA
BI-214	0.276	0.091	0.115	0.058		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA
PB-214	0.316	0.078	0.087	0.043		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA
RA-226	0.276	0.091	0.115	0.058		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA
RA-228	0.432	0.101	0.086	0.043		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA
AC-228	0.432	0.101	0.086	0.043		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA
TH-232	0.432	0.101	0.086	0.043		pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA
U-235	0.061	0.175	0.301	0.151	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 12:59	JDT	NA

NOTES:

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-09
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-023
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.909	1.364	0.710	0.355		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA
BI-212	0.380	0.286	0.432	0.216	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA
PB-212	0.477	0.099	0.096	0.048		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA
BI-214	0.435	0.111	0.089	0.044		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA
PB-214	0.344	0.095	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA
RA-226	0.435	0.111	0.089	0.044		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA
RA-228	0.370	0.131	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA
AC-228	0.370	0.131	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA
TH-232	0.370	0.131	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA
U-235	0.037	0.182	0.316	0.158	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:01	JDT	NA

NOTES:

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-04-10
Sample Collection Date: 08/19/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-024
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	6.991	1.139	0.578	0.289		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA
BI-212	0.118	0.232	0.400	0.200	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA
PB-212	0.444	0.094	0.086	0.043		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA
BI-214	0.330	0.093	0.093	0.047		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA
PB-214	0.342	0.089	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA
RA-226	0.330	0.093	0.093	0.047		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA
RA-228	0.260	0.129	0.212	0.106		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA
AC-228	0.260	0.129	0.212	0.106		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA
TH-232	0.260	0.129	0.212	0.106		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA
U-235	0.051	0.169	0.294	0.147	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:39	JDT	NA

NOTES:

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-01
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-025
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	7.913	1.140	0.314	0.157		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA
BI-212	0.458	0.316	0.482	0.241	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA
PB-212	0.700	0.124	0.111	0.056		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA
BI-214	0.635	0.135	0.107	0.054		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA
PB-214	0.702	0.135	0.094	0.047		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA
RA-226	0.635	0.135	0.107	0.054		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA
RA-228	0.900	0.150	0.124	0.062		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA
AC-228	0.900	0.150	0.124	0.062		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA
TH-232	0.900	0.150	0.124	0.062		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA
U-235	0.106	0.252	0.426	0.213	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:40	JDT	NA

NOTES:

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-02
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-026
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	8.758	1.154	0.564	0.282		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
BI-212	0.351	0.269	0.415	0.208	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
PB-212	0.732	0.119	0.097	0.048		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
BI-214	0.672	0.118	0.077	0.039		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
PB-214	0.722	0.130	0.103	0.052		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
RA-226	0.672	0.118	0.077	0.039		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
RA-228	0.836	0.180	0.103	0.052		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
AC-228	0.836	0.180	0.103	0.052		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
TH-232	0.836	0.180	0.103	0.052		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
U-235	0.021	0.203	0.349	0.175	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA

NOTES:

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2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-04
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-027
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.642	1.394	0.399	0.200		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
BI-212	0.241	0.335	0.564	0.282	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
PB-212	0.813	0.135	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
BI-214	0.786	0.165	0.126	0.063		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
PB-214	0.920	0.171	0.118	0.059		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
RA-226	0.786	0.165	0.126	0.063		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
RA-228	0.571	0.171	0.173	0.087		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
AC-228	0.571	0.171	0.173	0.087		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
TH-232	0.571	0.171	0.173	0.087		pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
U-235	0.057	0.227	0.391	0.196	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 13:41	JDT	NA
TH-228	1.052	0.209	0.038	0.010		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	43%
TH-230	1.058	0.208	0.059	0.021		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	43%
TH-232	0.959	0.194	0.036	0.009		pCi/g	ARS-031/Eichrom ACW-10	10/06/14 06:47	JH	43%

NOTES:

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2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-05
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-028
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	8.843	1.390	0.928	0.464		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA
BI-212	0.688	0.302	0.246	0.123		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA
PB-212	0.863	0.147	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA
BI-214	0.660	0.132	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA
PB-214	0.687	0.142	0.140	0.070		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA
RA-226	0.660	0.132	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA
RA-228	0.911	0.170	0.110	0.055		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA
AC-228	0.911	0.170	0.110	0.055		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA
TH-232	0.911	0.170	0.110	0.055		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA
U-235	0.071	0.230	0.393	0.197	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:10	JDT	NA

NOTES:

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2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-06
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-029
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	11.291	1.629	0.450	0.225		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA
BI-212	0.313	0.378	0.627	0.314	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA
PB-212	1.069	0.176	0.143	0.072		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA
BI-214	0.938	0.176	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA
PB-214	1.118	0.214	0.139	0.070		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA
RA-226	0.938	0.176	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA
RA-228	1.107	0.231	0.189	0.095		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA
AC-228	1.107	0.231	0.189	0.095		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA
TH-232	1.107	0.231	0.189	0.095		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA
U-235	-0.030	1.186	0.523	0.262	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:12	JDT	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-07
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-030
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.100	1.287	0.696	0.348		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA
BI-212	0.389	0.266	0.389	0.195	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA
PB-212	0.859	0.123	0.090	0.045		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA
BI-214	0.842	0.161	0.102	0.051		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA
PB-214	0.895	0.136	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA
RA-226	0.842	0.161	0.102	0.051		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA
RA-228	0.644	0.155	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA
AC-228	0.644	0.155	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA
TH-232	0.644	0.155	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA
U-235	0.152	0.211	0.351	0.176	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:13	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-08
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-031
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	7.552	1.175	0.373	0.187		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA
BI-212	0.114	0.249	0.441	0.221	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA
PB-212	0.353	0.089	0.090	0.045		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA
BI-214	0.204	0.088	0.124	0.062		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA
PB-214	0.309	0.087	0.103	0.052		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA
RA-226	0.204	0.088	0.124	0.062		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA
RA-228	0.338	0.108	0.171	0.086		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA
AC-228	0.338	0.108	0.171	0.086		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA
TH-232	0.338	0.108	0.171	0.086		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA
U-235	0.056	0.199	0.343	0.172	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:14	JDT	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-08D
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-032
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	7.375	1.185	0.591	0.296		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA
BI-212	0.000	0.267	0.558	0.279	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA
PB-212	0.284	0.078	0.083	0.042		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA
BI-214	0.221	0.086	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA
PB-214	0.364	0.091	0.094	0.047		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA
RA-226	0.221	0.086	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA
RA-228	0.305	0.119	0.107	0.054		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA
AC-228	0.305	0.119	0.107	0.054		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA
TH-232	0.305	0.119	0.107	0.054		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA
U-235	0.030	0.162	0.285	0.143	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:42	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-09
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-033
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.654	1.499	0.821	0.411		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA
BI-212	0.069	0.350	0.632	0.316	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA
PB-212	0.957	0.155	0.118	0.059		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA
BI-214	0.665	0.148	0.160	0.080		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA
PB-214	0.862	0.158	0.136	0.068		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA
RA-226	0.665	0.148	0.160	0.080		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA
RA-228	0.771	0.181	0.118	0.059		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA
AC-228	0.771	0.181	0.118	0.059		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA
TH-232	0.771	0.181	0.118	0.059		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA
U-235	0.011	0.173	0.313	0.157	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:43	JDT	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: FS-05-10
Sample Collection Date: 08/26/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-034
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.918	1.407	0.764	0.382		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA
BI-212	0.296	0.342	0.558	0.279	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA
PB-212	0.968	0.134	0.112	0.056		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA
BI-214	0.844	0.165	0.112	0.056		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA
PB-214	0.801	0.163	0.123	0.062		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA
RA-226	0.844	0.165	0.112	0.056		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA
RA-228	0.869	0.204	0.230	0.115		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA
AC-228	0.869	0.204	0.230	0.115		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA
TH-232	0.869	0.204	0.230	0.115		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA
U-235	0.098	0.225	0.382	0.191	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:45	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: HS-PA-D1
Sample Collection Date: 09/03/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-035
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	3.402	1.320	1.160	0.580		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA
BI-212	6.224	1.150	0.937	0.469		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA
PB-212	9.155	0.692	0.275	0.138		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA
BI-214	9.577	0.760	0.283	0.142		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA
PB-214	10.336	1.008	0.402	0.201		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA
RA-226	9.577	0.760	0.283	0.142		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA
RA-228	8.712	0.877	0.504	0.252		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA
AC-228	8.712	0.877	0.504	0.252		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA
TH-232	8.712	0.877	0.504	0.252		pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA
U-235	0.783	0.762	1.250	0.625	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 14:46	JDT	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: HS-PA-D2
Sample Collection Date: 08/29/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-036
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	6.154	1.754	1.400	0.700		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA
BI-212	8.430	1.598	1.270	0.635		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA
PB-212	11.380	0.885	0.331	0.166		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA
BI-214	14.644	1.138	0.334	0.167		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA
PB-214	15.294	1.469	0.473	0.237		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA
RA-226	14.644	1.138	0.334	0.167		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA
RA-228	10.195	1.064	0.527	0.264		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA
AC-228	10.195	1.064	0.527	0.264		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA
TH-232	10.195	1.064	0.527	0.264		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA
U-235	1.058	0.833	1.350	0.675	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 15:14	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: HS-PA-D3
Sample Collection Date: 08/29/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-037
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	7.634	1.278	0.597	0.299		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA
BI-212	1.084	0.413	0.379	0.190		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA
PB-212	1.497	0.232	0.169	0.085		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA
BI-214	4.035	0.393	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA
PB-214	4.287	0.485	0.184	0.092		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA
RA-226	4.035	0.393	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA
RA-228	1.683	0.299	0.157	0.079		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA
AC-228	1.683	0.299	0.157	0.079		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA
TH-232	1.683	0.299	0.157	0.079		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA
U-235	0.107	0.414	0.699	0.350	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 15:15	JDT	NA

NOTES:

Project Manager Review

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1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02394
Client Sample ID: HS-PA-D4
Sample Collection Date: 08/29/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: 832802
ARS Sample ID: ARS1-14-02394-038
Date Received: 09/08/14
Report Date: 10/08/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	4.064	1.047	0.984	0.492		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA
BI-212	5.889	1.240	0.961	0.481		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA
PB-212	8.150	0.652	0.249	0.125		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA
BI-214	6.395	0.574	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA
PB-214	7.358	0.762	0.298	0.149		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA
RA-226	6.395	0.574	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA
RA-228	8.179	0.789	0.375	0.188		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA
AC-228	8.179	0.789	0.375	0.188		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA
TH-232	8.179	0.789	0.375	0.188		pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA
U-235	-0.060	1.349	1.030	0.515	U	pCi/g	ARS-007/EPA 901.1M	10/02/14 15:18	JDT	NA

NOTES:

Project Manager Review

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QC Results per Analytical Batch

Analytical Batch	ARS1-B14-02332
SDG	ARS1-14-02394
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-020
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 10/02/14 08:10 | Analysis Technician: JDT

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-02332-01	LCS	AM-241	47300	3600	37946	125	780
ARS1-B14-02332-01	LCS	CO-60	67800	2800	59162	115	690
ARS1-B14-02332-01	LCS	CS-137	57900	2900	50459	115	330

Duplicate RER/DER/RPD

Analysis Date: 10/02/14 08:22 | Analysis Technician: JDT

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	47300	3613	46800	3579	0.07	0.20	1.1
CO-60	67800	2828	68400	2717	0.11	0.30	0.9
CS-137	57900	2880	58400	2448	0.09	0.26	0.9

Method Blank

Analysis Date: 10/02/14 08:12 | Analysis Technician: JDT

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-02332-03	MBL	AM-241	-10	150	34	U
ARS1-B14-02332-03	MBL	CO-60	-1	13	19	U
ARS1-B14-02332-03	MBL	CS-137	1	11	20	U

LELAP Certificate# 01949

ARS INTERNATIONAL

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-02333
SDG	ARS1-14-02394
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-020
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 10/02/14 11:35 | Analysis Technician: JDT

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-02333-01	LCS	AM-241	47100	3600	37946	124	710
ARS1-B14-02333-01	LCS	CO-60	67100	2600	59162	113	430
ARS1-B14-02333-01	LCS	CS-137	59200	2700	50459	117	300

Duplicate RER/DER/RPD

Analysis Date: 10/02/14 12:15 | Analysis Technician: JDT

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	47100	3576	46500	3554	0.09	0.24	1.3
CO-60	67100	2635	67400	2674	0.06	0.16	0.4
CS-137	59200	2738	60000	2513	0.15	0.42	1.3

Method Blank

Analysis Date: 10/02/14 11:33 | Analysis Technician: JDT

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-02333-03	MBL	AM-241	-3	38	27	U
ARS1-B14-02333-03	MBL	CO-60	-1	27	31	U
ARS1-B14-02333-03	MBL	CS-137	-2	22	22	U

LELAP Certificate# 01949

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-02296
SDG	ARS1-14-02394
Analysis	Thorium in Solid, Waste, Biota, Sediment
Analysis Test Method	ARS-031/Eichrom ACW-10
Analysis Code	ASP-A-009
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 10/06/14 06:47 | Analysis Technician: AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-02296-01	LCS	TH-230	5.8	1.4	6.3	92	0.67

Duplicate RER/DER/RPD

Analysis Date: 10/06/14 06:47 | Analysis Technician: AMRAD\BFORBES

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
TH-230	5.81	1.43	6.22	0.95	0.17	0.47	6.8

Method Blank

Analysis Date: 10/06/14 06:47, 10/06/14 06:47 | Analysis Technician: AMRAD\BFORBES, AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-02296-03	MBL	TH-228	0.009	0.012	0.020	U
ARS1-B14-02296-03	MBL	TH-230	0.065	0.030	0.025	
ARS1-B14-02296-03	MBL	TH-232	-0.001	0.010	0.027	U

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Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC**® GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

LELAP Cert# 01949 ***NELAP Cert# E87558***

ARS INTERNATIONAL
2609 North River Road
Port Allen, LA 70767-3469
PH: (225) 381-2991
FX: (225) 381-2998
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: _____
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3469
Phone: (225) 381-2991
Fax: (225) 381-2998
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	8/19/14	14:45	FS-02-01	1	S	X	X	X	X										
02	8/19/14	14:45	FS-02-01D	1	S	X	X	X											
03	8/19/14	15:07	FS-02-02	1	S	X	X	X											
04	8/19/14	14:47	FS-02-03	1	S	X	X	X											
05	8/19/14	14:43	FS-02-04	1	S	X	X	X											
06	8/19/14	14:40	FS-02-06	1	S	X	X	X											
07	8/19/14	14:36	FS-02-08	1	S	X	X	X											
08	8/19/14	15:22	FS-03-01	1	S	X	X	X											
09	8/19/14	15:22	FS-03-01D	1	S	X	X	X											
10	8/19/14	15:16	FS-03-02	1	S	X	X	X											
11	8/19/14	15:11	FS-03-04	1	S	X	X	X	X										
12	8/19/14	14:50	FS-03-06	1	S	X	X	X											
13	8/19/14	14:55	FS-03-08	1	S	X	X	X											
14																			
15																			
16																			
17																			
18																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: 9-5-14 @ 1600
Courier: FedEx
Air Bill Number: 7710 5421 7359

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

Samplers Name (Print): Jeff Knight
Samplers Signature: _____

	Relinquished by	Date	Time	Received by	Date	Time
Signature		9-5-14	1600		9.5.14	14:13
Printed Name	Jeffrey Knight			S. Holladay		
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

Cooler #1

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Port Allen, LA 70767-3469
PH: (225) 381-2991
FX: (225) 381-2996
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: _____
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3469
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	8/19/14	12:50	FS-04-01	1	S	X	X	X											
02	8/19/14	12:55	FS-04-02	1	S	X	X	X											
03	8/19/14	13:00	FS-04-03	1	S	X	X	X											
04	8/19/14	13:05	FS-04-04	1	S	X	X	X											
05	8/19/14	13:09	FS-04-05	1	S	X	X	X											
06	8/19/14	13:12	FS-04-06	1	S	X	X	X											
07	8/19/14	13:12	FS-04-06D	1	S	X	X	X											
08	8/19/14	13:15	FS-04-07	1	S	X	X	X	X										
09	8/19/14	13:20	FS-04-08	1	S	X	X	X											
10	8/19/14	13:24	FS-04-09	1	S	X	X	X											
11	8/19/14	13:30	FS-04-10	1	S	X	X	X											
12																			
13																			
14																			
15																			
16																			
17																			
18																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: 9-5-14 @ 1600
Courier: FedEx
Air Bill Number: _____

Special instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

Samplers Name (Print): Jeff Knight
Samplers Signature: _____

	Relinquished by	Date	Time	Received	Date	Time
Signature		9-5-14	1600		9-E-14	14:13
Printed Name	Jeffrey Knight			D. Holliday		
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

Cooler #2

ARS INTERNATIONAL
2609 North River Road
Port Allen, LA 70767-3469
PH: (225) 381-2991
FX: (225) 381-2996
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: _____
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3469
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	8/26/14	14:50	FS-05-01	1	S	X	X	X											
02	8/26/14	15:00	FS-05-02	1	S	X	X	X											
03	8/26/14	14:45	FS-05-04	1	S	X	X	X	X										
04	8/26/14	14:35	FS-05-05	1	S	X	X	X											
05	8/26/14	14:30	FS-05-06	1	S	X	X	X											
06	8/26/14	14:25	FS-05-07	1	S	X	X	X											
07	8/26/14	14:15	FS-05-08	1	S	X	X	X											
08	8/26/14	14:18	FS-05-08D	1	S	X	X	X											
09	8/26/14	14:10	FS-05-09	1	S	X	X	X											
10	8/26/14	14:00	FS-05-10	1	S	X	X	X											
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: 9-5-14 @1600
Courier: FedEx
Air Bill Number: _____

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

Samplers Name (Print): Jeff Knight
Samplers Signature: Jeff Knight

	Relinquished by	Date	Time	Received by	Date	Time
Signature	Jeff Knight	9-5-14	1600	J. Hilliday	9.8.14	A:13
Printed Name	Jeffrey Knight					
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

Cooler #3

ARS INTERNATIONAL
2809 North River Road
Port Allen, LA 70767-3469
PH: (225) 381-2991
FX: (225) 381-2996
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: _____
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2809 North River Rd
Port Allen, LA 70767-3469
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	9/3/14	10:00	HS-PA-D1	1	S	X	X	X											
02	8/29/14	14:00	HS-PA-D2	1	S	X	X	X											
03	8/29/14	15:00	HS-PA-D3	1	S	X	X	X											
04	8/29/14	16:00	HS-PA-D4	1	S	X	X	X											
05																			
06																			
07																			
08																			
09																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: 9-5-14 @ 1600 hrs
Courier: FedEx
Air Bill Number:

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

Samplers Name (Print): Jeff Knight
Samplers Signature: Jeff Knight

	Relinquished by	Date	Time	Received by	Date	Time
Signature	Jeff Knight	9-5-14	1600	S. Holliday	9.8.14	14:13
Printed Name	Jeffrey Knight			S. Holliday		
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

Cooler #4

Perma-Fix Environmental Svc.
2800 Solway Road
Knoxville, TN 37931
Phone: (865) 690-0501
Fax: (865) 342-7647

Purchase Order

Purchase Order No.	832802
Revision No.	0
Date	9/10/2014
Order Type	Regular Order
Vendor ID	118589
Project No:	144036
Reference No:	

TO:

American Radiation Services, Inc
2609 N. River Road
Port Allen, LA 70767

Phone: Fax:
Email:

SHIP TO:

Perma-Fix Environmental Services
Eric Laning
Perma-Fix Business Center
2800 Solway Road
Knoxville, TN 37931

BILL TO:

Perma-Fix Environmental Svc
8302 Dunwoody Place
Suite 250
Atlanta, GA 30350

Confirm to:

GFE	SHIP VIA	BUYER
No		LALCORN@perma-fix.com

ORDER DATE	AFE #	JDE PO #	TERMS
9/10/2014			Net Due 45 Days

CLIENT REIMBURSABLE	QA REQUIRED	PERIOD OF PERFORMANCE START	END
No	No		

LINE	PART NUMBER	QUANTITY	UNITS	DATE RQRD	PRICE	EXT. PRICE	ACCT	PROJECT	TASK
1	ANALYTICAL SERVICES	7,230.00	EA	9/10/2014	1.00	7,230.00	420500	144036	00104

Reference ARS Quote dated 27 AUG 2014

Notes: Rates are as follows:

Isotopic Thorium $107.00 each (not to exceed quantitiy of 15)

Gamma Spectrometry for Ra-226 and Ra-228 $75.00 (not to exceed quantity of 75)

Rates are based on 28-day turn-around times.

Lesli Alcorn

Digitally signed by Lesli Alcorn
DN: cn=Lesli Alcorn, o, ou=Contracts, email=lalcorn@perma-fix.com, c=US
Date: 2014.09.10 14:19:44 -04'00'

TOTAL **7,230.00**

Perma-Fix Buyer Date

Vendor/Subcontractor Date

Vendor/Subcontractor must acknowledge acceptance of this order and return within three (3) days. Reference PO/Subcontract number on all invoices. Perma-Fix's standard Purchase Order/Subcontract Order Terms and Conditions are incorporated herein by reference and are available to the vendor/subcontractor upon request. Federal agencies must insert FAR Clause 52.222-54, Employment Eligiblity Verifications into solicitations and awards issued on or after September 8, 2009.

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-02894

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
Perma-Fix / SEC
2800 Solway Road
Knoxville, TN 37931

elaning@perma-fix.com; jhubler@perma-fix.com
swalnicki@perma-fix.com

Phone: (865) 690-0501

Susan Reese
Project Manager Review

Virginia Mullegan
Management Review

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

ACLASS ACCREDITED DoD ELAP

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

November 26, 2014

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Job #: **Li Tungsten #144036**

Dear Mr. Laning;

On October 24, 2014, ARS International received 7 solid samples to be analyzed for Gamma Spectroscopy and Isotopic Thorium.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

Eugene Mulligan
Laboratory Management
ARS International

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

PROJECT SAMPLE IDENTIFICATION CROSS-REFERENCE TO ARS SAMPLE LABORATORY IDs

Job Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
Li Tungsten #144036	FS-06-01	ARS1-14-02894-001
Li Tungsten #144036	FS-06-02	ARS1-14-02894-002
Li Tungsten #144036	FS-06-03	ARS1-14-02894-003
Li Tungsten #144036	FS-06-04	ARS1-14-02894-004
Li Tungsten #144036	FS-06-05	ARS1-14-02894-005
Li Tungsten #144036	FS-06-05D	ARS1-14-02894-006
Li Tungsten #144036	FS-06-06	ARS1-14-02894-007

ANALYTICAL METHODS

All samples were dried and ground before analysis.

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

Thorium analyses were performed using **ARS-031, "Thorium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (ACW10)".**

ANALYTICAL RESULTS

The result data that are flagged with "U" indicate that the activity is below the MDC.

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

American Radiation Services Project Manager/Laboratory Director's Comments:
"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

Eugene Mullegan
Signature

Laboratory Management, ARS International
Title

11-26-14
Date

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02894
Client Sample ID: FS-06-01
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02894-001
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.631	1.544	0.767	0.384		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
TL-208	0.154	0.058	0.072	0.036		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
BI-212	0.230	0.326	0.542	0.271	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
PB-212	0.605	0.119	0.103	0.052		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
BI-214	0.559	0.136	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
PB-214	0.544	0.130	0.139	0.070		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
RA-226	-0.183	1.695	1.550	0.775	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
RA-228	0.530	0.182	0.263	0.132		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
TH-234	-0.026	0.149	0.188	0.094	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
AC-228	0.530	0.182	0.263	0.132		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
U-235	0.063	0.214	0.373	0.187	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
U-238	1.066	0.704	1.560	0.780	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:48	JDT	NA
TH-228	0.894	0.174	0.065	0.026		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	50%
TH-230	0.742	0.150	0.037	0.012		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	50%
TH-232	0.769	0.153	0.033	0.010		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	50%

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02894
Client Sample ID: FS-06-02
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02894-002
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.677	1.465	0.487	0.244		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
TL-208	0.288	0.073	0.062	0.031		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
BI-212	0.734	0.337	0.314	0.157		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
PB-212	0.927	0.145	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
BI-214	0.771	0.155	0.103	0.052		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
PB-214	0.847	0.173	0.142	0.071		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
RA-226	1.814	1.323	1.580	0.790		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
RA-228	1.077	0.210	0.120	0.060		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
TH-234	-0.018	0.194	0.180	0.090	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
AC-228	1.077	0.210	0.120	0.060		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
U-235	-0.131	0.375	0.417	0.209	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA
U-238	1.645	0.910	1.640	0.820		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:49	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02894
Client Sample ID: FS-06-03
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02894-003
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	12.042	1.614	0.808	0.404		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
TL-208	0.307	0.068	0.048	0.024		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
BI-212	0.572	0.259	0.234	0.117		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
PB-212	0.790	0.136	0.109	0.055		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
BI-214	0.678	0.136	0.126	0.063		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
PB-214	0.795	0.138	0.141	0.071		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
RA-226	2.902	1.077	1.160	0.580		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
RA-228	0.950	0.231	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
TH-234	-0.076	0.117	0.164	0.082	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
AC-228	0.950	0.231	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
U-235	0.047	0.205	0.355	0.178	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA
U-238	0.535	0.987	1.700	0.850	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 07:50	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02894
Client Sample ID: FS-06-04
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02894-004
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	11.422	1.714	0.780	0.390		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
TL-208	0.335	0.087	0.071	0.036		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
BI-212	1.321	0.487	0.353	0.177		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
PB-212	1.059	0.168	0.136	0.068		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
BI-214	0.639	0.160	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
PB-214	0.735	0.150	0.161	0.081		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
RA-226	0.989	0.968	1.630	0.815	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
RA-228	0.988	0.241	0.200	0.100		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
TH-234	-0.020	0.135	0.157	0.079	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
AC-228	0.988	0.241	0.200	0.100		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
U-235	0.168	0.225	0.377	0.189	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA
U-238	1.219	0.695	1.920	0.960	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 08:22	JDT	NA

NOTES:

Project Manager Review

Notes: ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02894
Client Sample ID: FS-06-05
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02894-005
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	12.609	1.706	0.427	0.214		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
TL-208	0.378	0.091	0.065	0.033		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
BI-212	0.740	0.340	0.344	0.172		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
PB-212	0.831	0.150	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
BI-214	0.634	0.150	0.162	0.081		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
PB-214	0.885	0.157	0.085	0.043		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
RA-226	2.043	1.151	1.340	0.670		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
RA-228	0.963	0.181	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
TH-234	-0.018	0.171	0.161	0.081	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
AC-228	0.963	0.181	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
U-235	0.135	0.273	0.463	0.232	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA
U-238	1.919	0.960	1.680	0.840		pCi/g	ARS-007/EPA 901.1M	11/19/14 08:23	JDT	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02894
Client Sample ID: FS-06-05D
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02894-006
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	11.075	1.641	0.734	0.367		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
TL-208	0.216	0.059	0.051	0.026		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
BI-212	0.740	0.335	0.280	0.140		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
PB-212	0.716	0.136	0.126	0.063		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
BI-214	0.725	0.150	0.108	0.054		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
PB-214	0.690	0.153	0.152	0.076		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
RA-226	2.221	1.323	1.470	0.735		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
RA-228	0.480	0.165	0.317	0.159		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
TH-234	-0.023	0.136	0.168	0.084	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
AC-228	0.480	0.165	0.317	0.159		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
U-235	-0.018	1.215	0.412	0.206	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA
U-238	0.706	0.999	1.700	0.850	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:01	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02894
Client Sample ID: FS-06-06
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02894-007
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	12.291	1.713	0.449	0.225		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
TL-208	0.322	0.077	0.081	0.040		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
BI-212	1.340	0.438	0.335	0.168		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
PB-212	0.896	0.148	0.119	0.060		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
BI-214	0.912	0.182	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
PB-214	1.083	0.188	0.129	0.065		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
RA-226	2.278	1.324	1.540	0.770		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
RA-228	0.794	0.194	0.222	0.111		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
TH-234	-0.004	1.009	0.199	0.100	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
AC-228	0.794	0.194	0.222	0.111		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
U-235	-0.030	1.184	0.462	0.231	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA
U-238	0.856	1.081	1.860	0.930	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:02	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

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QC Results per Analytical Batch

Analytical Batch	ARS1-B14-02965
SDG	ARS1-14-02894
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-025
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 11/19/14 07:11 | Analysis Technician: JDT

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-02965-01	LCS	AM-241	45900	3500	37946	121	780
ARS1-B14-02965-01	LCS	CO-60	66100	2800	59162	112	540
ARS1-B14-02965-01	LCS	CS-137	56600	2800	50459	112	290

Duplicate RER/DER/RPD

Analysis Date: 11/19/14 07:24 | Analysis Technician: JDT

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	45900	3515	44300	3393	0.23	0.65	3.5
CO-60	66100	2753	65200	2579	0.17	0.47	1.4
CS-137	56600	2812	57300	2649	0.13	0.35	1.2

Method Blank

Analysis Date: 11/19/14 07:10 | Analysis Technician: JDT

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-02965-03	MBL	AM-241	0	140	32	U
ARS1-B14-02965-03	MBL	CO-60	-1	20	12	U
ARS1-B14-02965-03	MBL	CS-137	3	11	20	U

LELAP Certificate# 01949

Analytical Batch	ARS1-B14-03010
SDG	ARS1-14-02894
Analysis	Thorium in Solid, Waste, Biota, Sediment
Analysis Test Method	ARS-031/Eichrom ACW-10
Analysis Code	ASP-A-009
Report Units	pCi/g

QC Results per Analytical Batch

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date	11/21/14 21:03	Analysis Technician	AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03010-01	LCS	TH-230	6.22	0.80	6.28	99	0.030

Duplicate RER/DER/RPD

Analysis Date	11/21/14 21:03	Analysis Technician	AMRAD\BFORBES

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
TH-230	6.22	0.80	6.21	0.80	0.01	0.02	0.2

Method Blank

Analysis Date	11/21/14 21:03 11/21/14 21:03	Analysis Technician	AMRAD\BFORBES AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03010-03	MBL	Th-228	0.027	0.023	0.032	U
ARS1-B14-03010-03	MBL	Th-230	0.111	0.039	0.025	
ARS1-B14-03010-03	MBL	Th-232	-0.0072	0.0064	0.026	U

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Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC®** GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

Notes: ARS International assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

LELAP Cert# 01949 ***NELAP Cert# E87558***

ARS INTERNATIONAL
2609 North River Road
Port Allen, LA 70767-3469
PH: (225) 381-2991
FX: (225) 381-2996
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order:
Job #: Li Tungsten #144036
Contract #:

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3469
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	10/17/14	9:20	FS-06-01	1	S	X	X	X	X										
02	10/17/14	9:25	FS-06-02	1	S	X	X	X											
03	10/17/14	9:30	FS-06-03	1	S	X	X	X											
04	10/17/14	9:35	FS-06-04	1	S	X	X	X											
05	10/17/14	9:45	FS-06-05	1	S	X	X	X											
06	10/17/14	9:45	FS-06-05D	1	S	X	X	X											
07	10/17/14	9:55	FS-06-06	1	S	X	X	X											
08																			
09																			
10																			
11																			
12																			
13																			
13																			
14																			
15																			
16																			
17																			
18																			

Method of Shipment: Standard Overnight
Date & Time of Shipment:
Courier: FedEx
Air Bill Number:

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

Samplers Name (Print): Allan Gumbert
Samplers Signature:

	Relinquished by	Date	Time	Received by	Date	Time
Signature		10-21-14	0730		10.24.14	0841
Printed Name	Allan Gumbert					
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-02895

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
Perma-Fix / SEC
2800 Solway Road
Knoxville, TN 37931

elaning@perma-fix.com; jhubler@perma-fix.com
swalnicki@perma-fix.com

Phone: (865) 690-0501

Susan Reese
Project Manager Review

Virginia Mulligan
Management Review

Notes: ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

ACLASS ACCREDITED DoD ELAP

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

November 26, 2014

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Job #: **Li Tungsten #144036**

Dear Mr. Laning;

On October 24, 2014, ARS International received 6 solid samples to be analyzed for Gamma Spectroscopy and Isotopic Thorium.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

Virginia Mulligan

Laboratory Management
ARS International

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1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

**PROJECT SAMPLE IDENTIFICATION
CROSS-REFERENCE
TO ARS SAMPLE LABORATORY IDs**

Job Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
Li Tungsten #144036	FS-06-07	ARS1-14-02895-001
Li Tungsten #144036	FS-06-08	ARS1-14-02895-002
Li Tungsten #144036	FS-06-09	ARS1-14-02895-003
Li Tungsten #144036	FS-06-10	ARS1-14-02895-004
Li Tungsten #144036	FS-02-10	ARS1-14-02895-005
Li Tungsten #144036	FS-01-08	ARS1-14-02895-006

ANALYTICAL METHODS

All samples were dried and ground before analysis.

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

Thorium analyses were performed using **ARS-031, "Thorium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (ACW10)".**

ANALYTICAL RESULTS

The result data that are flagged with "U" indicate that the activity is below the MDC.

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American Radiation Services Project Manager/Laboratory Director's Comments:
"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

Signature	Title	Date
Virginia Mulligan	Laboratory Management, ARS International	11-26-14

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02895
Client Sample ID: FS-06-07
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02895-001
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	8.537	1.241	0.697	0.349		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
TL-208	0.323	0.063	0.037	0.018		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
BI-212	0.143	0.279	0.481	0.241	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
PB-212	0.720	0.107	0.089	0.045		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
BI-214	0.673	0.133	0.087	0.044		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
PB-214	0.653	0.128	0.095	0.048		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
RA-226	1.772	0.889	1.060	0.530		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
RA-228	0.874	0.174	0.077	0.039		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
TH-234	0.066	0.036	0.123	0.062	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
AC-228	0.874	0.174	0.077	0.039		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
U-235	-0.042	0.522	0.359	0.180	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA
U-238	0.237	0.921	1.600	0.800	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:17	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-02895
Client Sample ID: FS-06-08
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02895-002
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	8.010	1.398	0.919	0.460		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
TL-208	0.152	0.057	0.073	0.037		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
BI-212	0.192	0.330	0.561	0.281	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
PB-212	0.651	0.125	0.111	0.056		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
BI-214	0.627	0.150	0.160	0.080		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
PB-214	0.679	0.132	0.117	0.059		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
RA-226	0.701	0.865	1.490	0.745	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
RA-228	0.493	0.149	0.242	0.121		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
TH-234	0.068	0.089	0.147	0.074	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
AC-228	0.493	0.149	0.242	0.121		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
U-235	-0.064	0.477	0.362	0.181	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA
U-238	0.213	0.888	1.570	0.785	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:42	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02895
Client Sample ID: FS-06-09
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02895-003
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.062	1.386	0.416	0.208		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
TL-208	0.225	0.065	0.078	0.039		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
BI-212	0.575	0.279	0.280	0.140		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
PB-212	0.785	0.128	0.099	0.049		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
BI-214	0.643	0.143	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
PB-214	0.832	0.148	0.102	0.051		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
RA-226	1.878	0.999	1.280	0.640		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
RA-228	0.719	0.194	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
TH-234	0.026	0.095	0.163	0.082	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
AC-228	0.719	0.194	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
U-235	-0.144	0.392	0.456	0.228	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA
U-238	1.487	0.792	1.630	0.815	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:43	JDT	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

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ARS Sample Delivery Group: ARS1-14-02895
Client Sample ID: FS-06-10
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02895-004
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.344	1.358	0.763	0.382		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
TL-208	0.294	0.073	0.058	0.029		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
BI-212	0.979	0.361	0.308	0.154		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
PB-212	0.780	0.135	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
BI-214	0.665	0.142	0.095	0.048		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
PB-214	0.775	0.166	0.155	0.078		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
RA-226	1.072	0.777	1.270	0.635	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
RA-228	0.684	0.168	0.218	0.109		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
TH-234	-0.004	0.496	0.167	0.084	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
AC-228	0.684	0.168	0.218	0.109		pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
U-235	0.017	0.219	0.382	0.191	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA
U-238	0.733	0.454	1.580	0.790	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 09:49	JDT	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02895
Client Sample ID: FS-02-10
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02895-005
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	8.674	1.590	0.933	0.467		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
TL-208	0.168	0.072	0.096	0.048		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
BI-212	0.065	0.370	0.677	0.339	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
PB-212	0.695	0.152	0.147	0.074		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
BI-214	0.498	0.154	0.183	0.092		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
PB-214	0.779	0.194	0.186	0.093		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
RA-226	0.870	0.991	1.710	0.855	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
RA-228	0.555	0.223	0.285	0.143		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
TH-234	0.052	0.111	0.188	0.094	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
AC-228	0.555	0.223	0.285	0.143		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
U-235	0.146	0.302	0.513	0.257	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
U-238	1.122	0.825	2.030	1.015	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 10:15	JDT	NA
TH-228	0.855	0.167	0.073	0.030		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	54%
TH-230	1.112	0.196	0.045	0.016		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	54%
TH-232	0.862	0.162	0.026	0.007		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	54%

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02895
Client Sample ID: FS-01-08
Sample Collection Date: 10/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02895-006
Date Received: 10/22/14
Report Date: 11/26/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	9.073	1.231	0.309	0.155		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
TL-208	0.108	0.041	0.053	0.027		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
BI-212	0.091	0.252	0.446	0.223	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
PB-212	0.357	0.082	0.082	0.041		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
BI-214	0.356	0.097	0.100	0.050		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
PB-214	0.405	0.089	0.096	0.048		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
RA-226	1.296	0.866	1.040	0.520		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
RA-228	0.385	0.116	0.159	0.080		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
TH-234	0.029	0.074	0.126	0.063	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
AC-228	0.385	0.116	0.159	0.080		pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
U-235	0.034	0.180	0.314	0.157	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA
U-238	0.143	0.721	1.290	0.645	U	pCi/g	ARS-007/EPA 901.1M	11/19/14 10:16	JDT	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

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QC Results per Analytical Batch

Analytical Batch	ARS1-B14-02965
SDG	ARS1-14-02895
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-025
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 11/19/14 07:11 | Analysis Technician: JDT

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-02965-01	LCS	AM-241	45900	3500	37946	121	780
ARS1-B14-02965-01	LCS	CO-60	66100	2800	59162	112	540
ARS1-B14-02965-01	LCS	CS-137	56600	2800	50459	112	290

Duplicate RER/DER/RPD

Analysis Date: 11/19/14 07:24 | Analysis Technician: JDT

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	45900	3515	44300	3393	0.23	0.65	3.5
CO-60	66100	2753	65200	2579	0.17	0.47	1.4
CS-137	56600	2812	57300	2649	0.13	0.35	1.2

Method Blank

Analysis Date: 11/19/14 07:10 | Analysis Technician: JDT

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-02965-03	MBL	AM-241	0	140	32	U
ARS1-B14-02965-03	MBL	CO-60	-1	20	12	U
ARS1-B14-02965-03	MBL	CS-137	3	11	20	U

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ARS INTERNATIONAL

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-03010
SDG	ARS1-14-02895
Analysis	Thorium in Solid, Waste, Biota, Sediment
Analysis Test Method	ARS-031/Eichrom ACW-10
Analysis Code	ASP-A-009
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03010-01	LCS	TH-230	6.22	0.80	6.28	99	0.030

Duplicate RER/DER/RPD

Analysis Date: 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
TH-230	6.22	0.80	6.21	0.80	0.01	0.02	0.2

Method Blank

Analysis Date: 11/21/14 21:03 / 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES / AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03010-03	MBL	Th-228	0.027	0.023	0.032	U
ARS1-B14-03010-03	MBL	Th-230	0.111	0.039	0.025	
ARS1-B14-03010-03	MBL	Th-232	-0.0072	0.0064	0.026	U

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Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC**® GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

Notes: ARS International assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

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ARS INTERNATIONAL
2609 North River Road
Port Allen, LA 70767-3469
PH: (225) 381-2991
FX: (225) 381-2996
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: LI Tungsten #144036
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3469
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	10/17/14	10:05	FS-06-07	1	S	X	X	X											
02	10/17/14	10:10	FS-06-08	1	S	X	X	X											
03	10/17/14	10:20	FS-06-09	1	S	X	X	X											
04	10/17/14	10:30	FS-06-10	1	S	X	X	X											
05	10/17/14	8:35	FS-02-10	1	S	X	X	X	X										
06	10/17/14	8:30	FS-01-08	1	S	X	X	X											
07																			
08																			
09																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: _____ Courier: FedEx
Air Bill Number: _____

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

Samplers Name (Print): Allan Gumbert
Samplers Signature: [signature]

	Relinquished by	Date	Time	Received by	Date	Time
Signature	[signature]	10-21-14	0730	[signature]	10.21.14	0847
Printed Name	Allan Gumbert					
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-03027

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
Perma-Fix Environmental Services, Inc.
2800 Solway Road
Knoxville, TN 37931
jhubler@perma-fix.com; elaning@perma-fix.com
swalnicki@perma-fix.com

Phone: 865-690-0501

Project Manager Review

Management Review

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

ACCREDITED
DoD ELAP

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

December 2, 2014

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Job #: **Li Tungsten #144036**

Dear Mr. Laning;

On November 3, 2014, ARS International received 6 solid samples to be analyzed for Gamma Spectroscopy and Isotopic Thorium.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

James D. Pu

Laboratory Management
ARS International

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

**PROJECT SAMPLE IDENTIFICATION
CROSS-REFERENCE
TO ARS SAMPLE LABORATORY IDs**

Job Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
Li Tungsten #144036	FS-01-04	ARS1-14-03027-001
Li Tungsten #144036	FS-01-07	ARS1-14-03027-002
Li Tungsten #144036	FS-01-01	ARS1-14-03027-003
Li Tungsten #144036	FS-02-05	ARS1-14-03027-004
Li Tungsten #144036	FS-02-07	ARS1-14-03027-005
Li Tungsten #144036	FS-02-09	ARS1-14-03027-006

ANALYTICAL METHODS

All samples were dried and ground before analysis.

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

Thorium analyses were performed using **ARS-031, "Thorium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (ACW10)".**

ANALYTICAL RESULTS

The result data that are flagged with "U" indicate that the activity is below the MDC.

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American Radiation Services Project Manager/Laboratory Director's Comments:

"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

James D. Lu	Laboratory Management, ARS International	12-02-14
Signature	**Title**	**Date**

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03027
Client Sample ID: FS-01-04
Sample Collection Date: 10/23/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03027-001
Date Received: 11/03/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.861	0.196	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
K-40	10.400	1.561	0.711	0.356		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
TL-208	0.294	0.072	0.059	0.029		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
BI-212	0.000	0.410	0.741	0.371	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
PB-212	0.791	0.138	0.118	0.059		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
BI-214	0.883	0.170	0.123	0.062		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
PB-214	0.822	0.146	0.155	0.078		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
RA-226	1.081	0.837	1.250	0.625	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
RA-228	0.861	0.196	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
TH-234	0.102	0.067	0.178	0.089	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
U-235	0.236	0.231	0.375	0.188	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
U-238	1.371	1.098	1.460	0.730	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
TH-228	0.684	0.148	0.079	0.033		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	47%
TH-230	0.667	0.141	0.058	0.022		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	47%
TH-232	0.644	0.138	0.060	0.023		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	47%

NOTES:

Project Manager Review

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ARS Sample Delivery Group: ARS1-14-03027
Client Sample ID: FS-01-07
Sample Collection Date: 10/23/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03027-002
Date Received: 11/03/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.402	0.167	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
K-40	7.718	1.230	0.391	0.196		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
TL-208	0.237	0.063	0.051	0.025		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
BI-212	0.626	0.277	0.263	0.132		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
PB-212	0.728	0.119	0.095	0.047		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
BI-214	0.678	0.145	0.109	0.055		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
PB-214	0.627	0.117	0.120	0.060		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
RA-226	1.359	0.983	1.250	0.625		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
RA-228	0.402	0.167	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
TH-234	0.004	0.090	0.157	0.079	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
U-235	0.113	0.218	0.371	0.186	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA
U-238	1.321	0.735	1.360	0.680	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:35	BZF	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-03027
Client Sample ID: FS-01-01
Sample Collection Date: 10/29/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03027-003
Date Received: 11/03/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.610	0.171	0.280	0.140		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
K-40	9.578	1.557	1.010	0.505		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
TL-208	0.223	0.068	0.065	0.032		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
BI-212	0.086	0.351	0.634	0.317	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
PB-212	0.707	0.140	0.131	0.066		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
BI-214	0.692	0.157	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
PB-214	0.770	0.150	0.092	0.046		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
RA-226	0.460	0.840	1.480	0.740	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
RA-228	0.610	0.171	0.280	0.140		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
TH-234	0.077	0.105	0.175	0.088	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
U-235	0.179	0.213	0.354	0.177	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA
U-238	1.220	0.870	1.790	0.895	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:36	BZF	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-03027
Client Sample ID: FS-02-05
Sample Collection Date: 10/29/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03027-004
Date Received: 11/03/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.602	0.184	0.279	0.140		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
K-40	7.940	1.330	0.466	0.233		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
TL-208	0.180	0.057	0.067	0.033		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
BI-212	0.712	0.274	0.216	0.108		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
PB-212	0.810	0.160	0.143	0.072		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
BI-214	0.719	0.160	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
PB-214	0.858	0.163	0.126	0.063		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
RA-226	1.883	0.870	1.220	0.610		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
RA-228	0.602	0.184	0.279	0.140		pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
TH-234	0.006	0.086	0.151	0.076	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
U-235	0.136	0.242	0.409	0.205	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA
U-238	0.975	0.778	1.810	0.905	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 08:38	BZF	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-03027
Client Sample ID: FS-02-07
Sample Collection Date: 10/29/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03027-005
Date Received: 11/03/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.301	0.120	0.211	0.106		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
K-40	9.718	1.407	0.610	0.305		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
TL-208	0.135	0.045	0.042	0.021		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
BI-212	0.161	0.264	0.448	0.224	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
PB-212	0.419	0.096	0.093	0.046		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
BI-214	0.332	0.102	0.122	0.061		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
PB-214	0.452	0.127	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
RA-226	0.839	0.588	0.875	0.438	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
RA-228	0.301	0.120	0.211	0.106		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
TH-234	-0.016	0.135	0.157	0.079	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
U-235	0.026	0.186	0.326	0.163	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
U-238	0.529	0.652	1.040	0.520	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-03027
Client Sample ID: FS-02-09
Sample Collection Date: 10/29/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03027-006
Date Received: 11/03/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.341	0.275	0.132	0.066		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
K-40	9.011	1.490	0.722	0.361		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
TL-208	0.540	0.108	0.077	0.039		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
BI-212	0.670	0.414	0.603	0.302		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
PB-212	1.478	0.225	0.174	0.087		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
BI-214	1.449	0.241	0.142	0.071		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
PB-214	1.701	0.271	0.178	0.089		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
RA-226	3.294	1.509	1.720	0.860		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
RA-228	1.341	0.275	0.132	0.066		pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
TH-234	-0.013	0.390	0.255	0.128	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
U-235	0.200	0.332	0.557	0.279	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA
U-238	1.561	1.195	2.360	1.180	U	pCi/g	ARS-007/EPA 901.1M	11/25/14 09:19	BZF	NA

NOTES:

Project Manager Review

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Analytical Batch	ARS1-B14-03010
SDG	ARS1-14-03027
Analysis	Thorium in Solid, Waste, Biota, Sediment
Analysis Test Method	ARS-031/Eichrom ACW-10
Analysis Code	ASP-A-009
Report Units	pCi/g

QC Results per Analytical Batch

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03010-01	LCS	TH-230	6.22	0.80	6.28	99	0.030

Duplicate RER/DER/RPD

Analysis Date: 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
TH-230	6.22	0.80	6.21	0.80	0.01	0.02	0.2

Method Blank

Analysis Date: 11/21/14 21:03 / 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES / AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03010-03	MBL	Th-228	0.027	0.023	0.032	U
ARS1-B14-03010-03	MBL	Th-230	0.111	0.039	0.025	
ARS1-B14-03010-03	MBL	Th-232	-0.0072	0.0064	0.026	U

Susan Keese

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QC Results per Analytical Batch

Analytical Batch	ARS1-B14-03058
SDG	ARS1-14-03027
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-025
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 11/25/14 07:37 | Analysis Technician: BZF

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03058-01	LCS	AM-241	45700	3500	37946	120	760
ARS1-B14-03058-01	LCS	CO-60	64700	2700	59162	109	590
ARS1-B14-03058-01	LCS	CS-137	57800	2900	50459	115	250

Duplicate RER/DER/RPD

Analysis Date: 11/25/14 07:50 | Analysis Technician: BZF

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	45700	3497	46500	3562	0.11	0.31	1.7
CO-60	64700	2707	66300	2618	0.30	0.84	2.4
CS-137	57800	2863	58500	2710	0.12	0.34	1.2

Method Blank

Analysis Date: 11/25/14 07:36 | Analysis Technician: BZF

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03058-03	MBL	AM-241	4	15	27	U
ARS1-B14-03058-03	MBL	CO-60	6	10	19	U
ARS1-B14-03058-03	MBL	CS-137	-4	16	23	U

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Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC®** GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

LELAP Cert# 01949 ***NELAP Cert# E87558***

...chase Order:
Job #: Li Tungsten #144036
Contract #:

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3469
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

...com
...mail: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

TWENTY EIGHT (28) DAY TAT

Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
10/23/14	3:15	FS-01-04	1	S	X	X	X	X										
10/23/14	3:25	FS-01-07	1	S	X	X	X											
10/29/14	9:40	FS-01-01	1	S	X	X	X											
10/29/14	9:20	FS-02-05	1	S	X	X	X											
10/29/14	9:30	FS-02-07	1	S	X	X	X											
10/29/14	2:00	FS-02-09	1	S	X	X	X											

...thod of Shipment: Standard Overnight
...Time of Shipment: 10-30-14 0800
Courier: FedEx
Air Bill Number: 7716 7890 9166
...s Name (Print): Allan Gumbert
Samplers Signature:

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

	Relinquished by	Date	Time	Received by	Date	Time
...nature		10-30-14	0800		11-3-14	1634
...d Name	Allan Gumbert					
...ture						
...lame						

...of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-02978

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
Perma-Fix Environmental Services, Inc.
2800 Solway Road
Knoxville, TN 37931
jhubler@perma-fix.com; elaning@perma-fix.com
swalnicki@perma-fix.com

Phone: 865-690-0501

Project Manager Review

Management Review

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

ACCREDITED DoD ELAP

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

December 2, 2014

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Job #: **Li Tungsten #144036**

Dear Mr. Laning;

On October 31, 2014, ARS International received 18 solid samples to be analyzed for Gamma Spectroscopy and Isotopic Thorium.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

James D. Lu

Laboratory Management
ARS International

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

**PROJECT SAMPLE IDENTIFICATION
CROSS-REFERENCE
TO ARS SAMPLE LABORATORY IDs**

Job Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
Li Tungsten #144036	2099-1B 0-6"	ARS1-14-02978-001
Li Tungsten #144036	2099-1B bottom 8'	ARS1-14-02978-002
Li Tungsten #144036	2099-1B bias 5'	ARS1-14-02978-003
Li Tungsten #144036	2097 0-6"	ARS1-14-02978-004
Li Tungsten #144036	2097 bottom 8'	ARS1-14-02978-005
Li Tungsten #144036	2097 bias 4'	ARS1-14-02978-006
Li Tungsten #144036	2098-4A 0-6"	ARS1-14-02978-007
Li Tungsten #144036	2098-4A bottom 8'	ARS1-14-02978-008
Li Tungsten #144036	2098-4A bias 2'	ARS1-14-02978-009
Li Tungsten #144036	2100-10B 0-6"	ARS1-14-02978-010
Li Tungsten #144036	2100-10B bottom 8'	ARS1-14-02978-011
Li Tungsten #144036	2100-10B bias 6'	ARS1-14-02978-012
Li Tungsten #144036	2095-EA4 0-6"	ARS1-14-02978-013
Li Tungsten #144036	2095-EA4 bottom 8'	ARS1-14-02978-014
Li Tungsten #144036	2095-EA4 bias 4'	ARS1-14-02978-015
Li Tungsten #144036	2096-16 (EA-3) 0-6"	ARS1-14-02978-016
Li Tungsten #144036	2096-16 (EA-3) bottom 8'	ARS1-14-02978-017
Li Tungsten #144036	2096-16 (EA-3) bias 7'	ARS1-14-02978-018

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ANALYTICAL METHODS

All samples were dried and ground before analysis. We did not receive enough of samples #1, #4, #7 or #10 to prep in a tuna can with no headspace. Per your email, we were directed to proceed with the analysis.

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

Thorium analyses were performed using **ARS-031, "Thorium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (ACW10)".**

ANALYTICAL RESULTS

The result data that are flagged with "U" indicate that the activity is below the MDC.

American Radiation Services Project Manager/Laboratory Director's Comments:
"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

James D. Rue	Laboratory Management, ARS International	12-02-14
Signature	**Title**	**Date**

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2099-1B 0-6
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-001
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.732	0.208	0.186	0.093		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
K-40	9.248	1.724	1.030	0.515		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
TL-208	0.265	0.070	0.049	0.024		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
BI-212	0.218	0.414	0.713	0.357	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
PB-212	0.871	0.157	0.123	0.062		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
BI-214	0.552	0.172	0.205	0.103		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
PB-214	0.775	0.197	0.217	0.109		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
RA-226	1.042	1.129	1.620	0.810	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
RA-228	0.732	0.208	0.186	0.093		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
TH-234	-0.006	3.840	0.174	0.087	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
U-235	0.009	0.201	0.371	0.186	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
U-238	1.600	0.996	1.940	0.970	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
TH-228	0.879	0.163	0.066	0.028		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	63%
TH-230	0.977	0.172	0.042	0.015		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	63%
TH-232	0.731	0.141	0.048	0.018		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	63%

NOTES: Headspace in tuna can

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2099-1B bottom 8
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-002
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.768	0.146	0.144	0.072		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
K-40	15.512	1.869	0.385	0.193		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
TL-208	0.271	0.084	0.071	0.035		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
BI-212	0.435	0.364	0.573	0.287	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
PB-212	0.830	0.137	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
BI-214	0.468	0.119	0.127	0.064		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
PB-214	0.724	0.147	0.090	0.045		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
RA-226	1.843	0.924	1.210	0.605		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
RA-228	0.768	0.146	0.144	0.072		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
TH-234	0.040	0.100	0.169	0.085	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
U-235	-0.129	0.330	0.380	0.190	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA
U-238	0.261	1.072	1.870	0.935	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:54	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2099-1B bias 5
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-003
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.531	0.151	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
K-40	8.772	1.246	0.678	0.339		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
TL-208	0.250	0.057	0.041	0.021		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
BI-212	0.354	0.304	0.477	0.239	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
PB-212	0.615	0.113	0.098	0.049		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
BI-214	0.676	0.134	0.099	0.050		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
PB-214	0.572	0.105	0.114	0.057		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
RA-226	1.137	0.728	0.975	0.488		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
RA-228	0.531	0.151	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
TH-234	-0.014	0.185	0.144	0.072	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
U-235	0.130	0.193	0.323	0.162	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA
U-238	8.908	2.173	1.900	0.950		pCi/g	ARS-007/EPA 901.1M	11/24/14 10:58	BZF	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself.*
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The results in this report pertain only to the samples tested and are intended solely for the use of the client.

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2097 0-6
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-004
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.354	0.163	0.274	0.137		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
K-40	4.343	1.055	0.840	0.420		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
TL-208	0.095	0.050	0.073	0.036		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
BI-212	0.065	0.350	0.643	0.322	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
PB-212	0.362	0.122	0.130	0.065		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
BI-214	0.279	0.117	0.162	0.081		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
PB-214	0.346	0.103	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
RA-226	0.471	0.751	1.350	0.675	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
RA-228	0.354	0.163	0.274	0.137		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
TH-234	-0.006	0.256	0.156	0.078	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
U-235	0.134	0.232	0.393	0.197	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA
U-238	0.648	0.887	1.560	0.780	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:00	BZF	NA

NOTES: Headspace in tuna can

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2097 bottom 8
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-005
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.255	0.101	0.185	0.093		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
K-40	5.524	1.066	0.817	0.409		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
TL-208	0.124	0.041	0.036	0.018		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
BI-212	0.085	0.261	0.463	0.232	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
PB-212	0.274	0.088	0.099	0.050		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
BI-214	0.289	0.105	0.130	0.065		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
PB-214	0.322	0.080	0.101	0.051		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
RA-226	0.458	0.603	1.060	0.530	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
RA-228	0.255	0.101	0.185	0.093		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
TH-234	-0.005	0.368	0.120	0.060	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
U-235	0.117	0.153	0.257	0.129	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA
U-238	0.786	0.524	1.120	0.560	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:31	BZF	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2097 bias 4
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-006
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.135	0.127	0.205	0.103	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
K-40	-0.082	3.299	2.370	1.185	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
TL-208	0.054	0.035	0.054	0.027	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
BI-212	0.161	0.238	0.407	0.204	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
PB-212	0.359	0.084	0.080	0.040		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
BI-214	0.257	0.087	0.104	0.052		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
PB-214	0.267	0.081	0.098	0.049		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
RA-226	0.142	0.624	1.160	0.580	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
RA-228	0.135	0.127	0.205	0.103	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
TH-234	-0.037	0.098	0.132	0.066	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
U-235	0.006	0.161	0.288	0.144	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
U-238	0.669	0.536	1.260	0.630	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2098-4A 0-6
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-007
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.122	0.223	0.084	0.042		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
K-40	13.127	1.659	0.758	0.379		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
TL-208	0.254	0.065	0.055	0.028		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
BI-212	0.032	0.411	0.728	0.364	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
PB-212	0.709	0.122	0.104	0.052		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
BI-214	0.845	0.144	0.079	0.040		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
PB-214	0.741	0.140	0.153	0.077		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
RA-226	2.519	1.177	1.250	0.625		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
RA-228	1.122	0.223	0.084	0.042		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
TH-234	-0.012	0.318	0.181	0.091	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
U-235	-0.020	0.799	0.450	0.225	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA
U-238	0.352	0.949	1.640	0.820	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:32	BZF	NA

NOTES: Headspace in tuna can

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2098-4A bottom 8
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-008
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.233	0.165	0.253	0.127	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
K-40	18.881	2.145	0.411	0.206		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
TL-208	0.065	0.045	0.071	0.035	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
BI-212	0.035	0.302	0.556	0.278	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
PB-212	0.345	0.101	0.099	0.050		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
BI-214	0.189	0.091	0.133	0.067		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
PB-214	0.294	0.096	0.129	0.065		pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
RA-226	0.537	0.690	1.050	0.525	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
RA-228	0.233	0.165	0.253	0.127	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
TH-234	0.045	0.074	0.124	0.062	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
U-235	-0.019	3.675	0.327	0.164	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA
U-238	0.701	0.763	1.320	0.660	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 11:33	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2098-4A bias 2
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-009
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.486	0.219	0.292	0.146		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
K-40	17.839	2.324	0.859	0.430		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
TL-208	0.216	0.072	0.088	0.044		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
BI-212	0.484	0.409	0.626	0.313	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
PB-212	0.545	0.126	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
BI-214	0.628	0.159	0.143	0.072		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
PB-214	0.607	0.143	0.186	0.093		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
RA-226	1.030	0.917	1.550	0.775	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
RA-228	0.486	0.219	0.292	0.146		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
TH-234	0.114	0.104	0.167	0.084	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
U-235	0.005	0.252	0.448	0.224	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
U-238	1.530	0.804	1.810	0.905	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2100-10B 0-6
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-010
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.193	0.274	0.191	0.096		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
K-40	12.400	2.052	0.686	0.343		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
TL-208	0.420	0.123	0.094	0.047		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
BI-212	0.590	0.540	0.857	0.429	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
PB-212	1.319	0.241	0.200	0.100		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
BI-214	1.022	0.246	0.203	0.102		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
PB-214	1.264	0.260	0.157	0.079		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
RA-226	2.341	1.747	2.190	1.095		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
RA-228	1.193	0.274	0.191	0.096		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
TH-234	0.052	0.141	0.242	0.121	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
U-235	-0.026	1.324	0.649	0.325	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
U-238	1.730	1.031	2.900	1.450	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:21	BZF	NA
TH-228	0.894	0.177	0.076	0.031		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	43%
TH-230	0.894	0.173	0.035	0.011		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	43%
TH-232	0.770	0.155	0.029	0.007		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	43%

NOTES: Headspace in tuna can

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2100-10B bottom 8
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-011
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.796	0.172	0.136	0.068		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
K-40	14.514	1.886	0.992	0.496		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
TL-208	0.301	0.076	0.062	0.031		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
BI-212	0.945	0.335	0.256	0.128		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
PB-212	0.869	0.152	0.138	0.069		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
BI-214	0.902	0.169	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
PB-214	0.815	0.153	0.144	0.072		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
RA-226	1.896	1.173	1.370	0.685		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
RA-228	0.796	0.172	0.136	0.068		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
TH-234	-0.026	0.167	0.175	0.088	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
U-235	0.070	0.228	0.390	0.195	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA
U-238	1.446	0.762	1.460	0.730	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:22	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2100-10B bias 6
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-012
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.827	0.196	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
K-40	9.755	1.527	0.489	0.245		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
TL-208	0.336	0.088	0.073	0.036		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
BI-212	0.300	0.422	0.710	0.355	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
PB-212	0.851	0.145	0.127	0.064		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
BI-214	0.939	0.186	0.140	0.070		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
PB-214	0.866	0.186	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
RA-226	2.309	1.069	1.390	0.695		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
RA-228	0.827	0.196	0.180	0.090		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
TH-234	-0.016	0.201	0.160	0.080	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
U-235	0.075	0.279	0.480	0.240	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA
U-238	1.144	0.634	2.040	1.020	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:23	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2095-EA4 0-6
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-013
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.553	0.162	0.192	0.096		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
K-40	9.118	1.371	0.626	0.313		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
TL-208	0.254	0.061	0.045	0.023		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
BI-212	0.808	0.267	0.157	0.079		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
PB-212	0.742	0.124	0.102	0.051		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
BI-214	0.680	0.132	0.090	0.045		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
PB-214	0.752	0.132	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
RA-226	1.309	1.055	1.320	0.660	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
RA-228	0.553	0.162	0.192	0.096		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
TH-234	0.016	0.086	0.149	0.075	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
U-235	-0.040	0.737	0.372	0.186	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
U-238	1.008	0.675	1.300	0.650	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2095-EA4 bottom 8
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-014
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.527	0.132	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
K-40	8.866	1.251	0.334	0.167		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
TL-208	0.283	0.063	0.047	0.023		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
BI-212	0.411	0.280	0.418	0.209	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
PB-212	0.887	0.119	0.087	0.043		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
BI-214	0.584	0.114	0.072	0.036		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
PB-214	0.759	0.132	0.068	0.034		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
RA-226	1.752	1.136	1.270	0.635		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
RA-228	0.527	0.132	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
TH-234	0.056	0.082	0.136	0.068	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
U-235	0.087	0.217	0.370	0.185	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA
U-238	1.129	0.717	1.290	0.645	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:56	BZF	NA

NOTES:

Project Manager Review

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LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2095-EA4 bias 4
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-015
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.533	0.139	0.200	0.100		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
K-40	7.802	1.251	0.812	0.406		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
TL-208	0.126	0.047	0.047	0.024		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
BI-212	0.580	0.257	0.224	0.112		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
PB-212	0.563	0.104	0.089	0.044		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
BI-214	0.440	0.115	0.130	0.065		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
PB-214	0.619	0.139	0.104	0.052		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
RA-226	0.854	0.659	0.932	0.466	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
RA-228	0.533	0.139	0.200	0.100		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
TH-234	-0.040	0.121	0.156	0.078	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
U-235	0.075	0.199	0.340	0.170	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
U-238	0.150	0.792	1.400	0.700	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2096-16 (EA-3) 0-6
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-016
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.500	0.172	0.262	0.131		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
K-40	10.679	1.665	0.530	0.265		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
TL-208	0.316	0.074	0.058	0.029		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
BI-212	0.378	0.425	0.700	0.350	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
PB-212	0.948	0.174	0.149	0.075		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
BI-214	0.696	0.169	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
PB-214	0.886	0.203	0.162	0.081		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
RA-226	2.087	1.049	1.350	0.675		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
RA-228	0.500	0.172	0.262	0.131		pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
TH-234	0.107	0.099	0.160	0.080	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
U-235	0.198	0.273	0.455	0.228	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA
U-238	1.516	0.776	1.630	0.815	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 12:57	BZF	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2096-16 (EA-3) bottom 8
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-017
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.385	0.239	0.148	0.074		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
K-40	12.124	1.813	0.821	0.411		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
TL-208	0.441	0.100	0.076	0.038		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
BI-212	1.246	0.529	0.451	0.226		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
PB-212	1.303	0.202	0.163	0.082		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
BI-214	1.177	0.266	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
PB-214	1.370	0.222	0.155	0.078		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
RA-226	3.372	1.545	1.760	0.880		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
RA-228	1.385	0.239	0.148	0.074		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
TH-234	0.028	0.138	0.236	0.118	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
U-235	0.280	0.291	0.475	0.238	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
U-238	1.721	0.978	2.070	1.035	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-02978
Client Sample ID: 2096-16 (EA-3) bias 7
Sample Collection Date: 10/27/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-02978-018
Date Received: 10/31/14
Report Date: 12/02/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.733	0.179	0.205	0.103		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
K-40	10.154	1.552	0.754	0.377		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
TL-208	0.259	0.068	0.073	0.037		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
BI-212	1.103	0.337	0.202	0.101		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
PB-212	0.771	0.159	0.143	0.072		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
BI-214	0.637	0.146	0.110	0.055		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
PB-214	0.722	0.135	0.162	0.081		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
RA-226	1.249	0.967	1.610	0.805	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
RA-228	0.733	0.179	0.205	0.103		pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
TH-234	0.057	0.078	0.130	0.065	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
U-235	0.199	0.238	0.394	0.197	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA
U-238	0.666	1.104	1.910	0.955	U	pCi/g	ARS-007/EPA 901.1M	11/24/14 13:29	BZF	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

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ARS INTERNATIONAL

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-03051
SDG	ARS1-14-02978
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-025
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 11/24/14 09:20 | Analysis Technician: BZF

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03051-01	LCS	AM-241	45800	3500	37946	121	820
ARS1-B14-03051-01	LCS	CO-60	64900	2700	59162	110	590
ARS1-B14-03051-01	LCS	CS-137	57100	2900	50459	113	360

Duplicate RER/DER/RPD

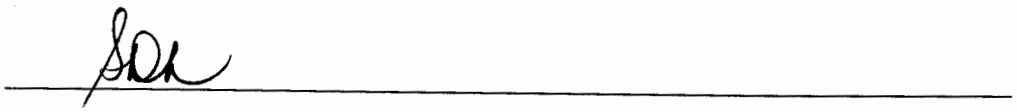
Analysis Date: 11/24/14 09:32 | Analysis Technician: BZF

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	45800	3521	44600	3416	0.17	0.48	2.7
CO-60	64900	2714	65800	2597	0.17	0.47	1.4
CS-137	57100	2850	58800	2724	0.30	0.83	2.9

Method Blank

Analysis Date: 11/24/14 09:19 | Analysis Technician: BZF

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03051-03	MBL	AM-241	-8	24	33	U
ARS1-B14-03051-03	MBL	CO-60	-1	20	12	U
ARS1-B14-03051-03	MBL	CS-137	0	15	27	U



LELAP Certificate# 01949

Analytical Batch	ARS1-B14-03010
SDG	ARS1-14-02978
Analysis	Thorium in Solid, Waste, Biota, Sediment
Analysis Test Method	ARS-031/Eichrom ACW-10
Analysis Code	ASP-A-009
Report Units	pCi/g

QC Results per Analytical Batch

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03010-01	LCS	TH-230	6.22	0.80	6.28	99	0.030

Duplicate RER/DER/RPD

Analysis Date: 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
TH-230	6.22	0.80	6.21	0.80	0.01	0.02	0.2

Method Blank

Analysis Date: 11/21/14 21:03 / 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES / AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03010-03	MBL	Th-228	0.027	0.023	0.032	U
ARS1-B14-03010-03	MBL	Th-230	0.111	0.039	0.025	
ARS1-B14-03010-03	MBL	Th-232	-0.0072	0.0064	0.026	U

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1 (800) 401-4277 • Fax (225) 381-2996

Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC®** GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

Notes: ARS International assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

LELAP Cert# 01949 ***NELAP Cert# E87558***

ARS INTERNATIONAL
2609 North River Road
Port Allen, LA 70767-3489
PH: (225) 381-2991
FX: (225) 381-2996
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: LI Tungsten #144036
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3489
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	10/27/14	7:55	2099-1B 0-6"	1	S	X	X	X	X										
02	10/27/14	8:00	2099-1B bottom 8'	1	S	X	X	X											
03	10/27/14	8:25	2099-1B bias 5'	1	S	X	X	X											
04	10/27/14	8:44	2097 0-6"	1	S	X	X	X											
05	10/27/14	8:48	2097 bottom 8'	1	S	X	X	X											
06	10/27/14	9:02	2097 bias 4'	1	S	X	X	X											
07	10/27/14	9:53	2098-4A 0-6"	1	S	X	X	X											
08	10/27/14	9:58	2098-4A bottom 8'	1	S	X	X	X											
09	10/27/14	10:22	2098-4A bias 2'	1	S	X	X	X											
10	10/27/14	10:47	2100-10B 0-6"	1	S	X	X	X	X										
11	10/27/14	10:53	2100-10B bottom 8'	1	S	X	X	X											
12	10/27/14	11:06	2100-10B bias 6'	1	S	X	X	X											
13	10/27/14	11:35	2095-EA4 0-6"	1	S	X	X	X											
14	10/27/14	11:40	2095-EA4 bottom 8'	1	S	X	X	X											
15	10/27/14	12:00	2095-EA4 bias 4'	1	S	X	X	X											
16	10/27/14	12:09	2096-16 (EA-3) 0-6"	1	S	X	X	X											
17	10/27/14	12:12	2096-16 (EA-3) bottom 8'	1	S	X	X	X											
18	10/27/14	12:28	2096-16 (EA-3) bias 7'	1	S	X	X	X											

Method of Shipment: Standard Overnight
Date & Time of Shipment: 10-30-14 0800
Courier: FedEx
Air Bill Number: 772167889 8511

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

Samplers Name (Print): Allan Gumbert
Samplers Signature: Allan Gumbert

	Relinquished by	Date	Time	Received by	Date	Time
Signature	Allan Gumbert	10-30-14	0800		10-31-14	1144
Printed Name	Allan Gumbert					
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | Si: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

Susan Leese

Subject: FW: Sample Discrepancy - Li Tungsten #144036

From: Eric Laning [mailto:elaning@perma-fix.com]
Sent: Tuesday, November 04, 2014 4:17 PM
To: Susan Leese
Cc: Steve Green; Project Managers; Jason Hubler; Scott Walnicki
Subject: RE: Sample Discrepancy - Li Tungsten #144036

Yes, go ahead and proceed. Thank you.

From: Susan Leese [mailto:sleese@amrad.com]
Sent: Tuesday, November 04, 2014 5:13 PM
To: Eric Laning
Cc: Steve Green; Project Managers; Jason Hubler; Scott Walnicki
Subject: RE: Sample Discrepancy - Li Tungsten #144036

Eric,
These samples are from chain dated 10-27-14 (see attached). We have enough sample to run the thorium, but the tunacans for those 4 samples all have headspace. It's your call whether to proceed -

---

From: Susan Leese [mailto:sleese@amrad.com]
Sent: Monday, November 03, 2014 4:57 PM
To: Eric Laning
Cc: Steve Green; Project Managers; Jason Hubler; Scott Walnicki
Subject: Sample Discrepancy - Li Tungsten #144036

Eric,
We didn't receive enough of fractions #1, #4, #7, or #10 to prep in a tuna can with no headspace. In addition, we need to run isotopic Th on fractions #1 and #10.

Thanks,
Susan

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-03153

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
Perma-Fix Environmental Services, Inc.
2800 Solway Road
Knoxville, TN 37931
jhubler@perma-fix.com; elaning@perma-fix.com
swalnicki@perma-fix.com

Phone: 865-690-0501

Project Manager Review

Management Review

Notes: ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

ACCREDITED DoD ELAP

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

December 11, 2014

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Job #: **Li Tungsten #144036**

Dear Mr. Laning;

On November 14, 2014, ARS International received 3 solid samples to be analyzed for Gamma Spectroscopy and Isotopic Thorium.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

James D. Lum

Laboratory Management
ARS International

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

**PROJECT SAMPLE IDENTIFICATION
CROSS-REFERENCE
TO ARS SAMPLE LABORATORY IDs**

Job Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
Li Tungsten #144036	FS-01-05	ARS1-14-03153-001
Li Tungsten #144036	FS-05-03	ARS1-14-03153-002
Li Tungsten #144036	FS-01-BIAS	ARS1-14-03153-003

ANALYTICAL METHODS

All samples were dried and ground before analysis.

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

Thorium analyses were performed using **ARS-031, "Thorium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (ACW10)".**

ANALYTICAL RESULTS

The result data that are flagged with "U" indicate that the activity is below the MDC.

American Radiation Services Project Manager/Laboratory Director's Comments:

"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

James D. Lee — **Signature**

Laboratory Management, ARS International — **Title**

12-11-14 — **Date**

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03153
Client Sample ID: FS-01-05
Sample Collection Date: 11/05/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03153-001
Date Received: 11/14/14
Report Date: 12/11/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.409	0.148	0.230	0.115		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
K-40	8.881	1.423	0.708	0.354		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
TL-208	0.169	0.054	0.045	0.023		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
BI-212	-0.005	0.290	0.542	0.271	U	pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
PB-212	0.455	0.115	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
BI-214	0.669	0.146	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
PB-214	0.552	0.122	0.138	0.069		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
RA-226	1.180	0.778	1.100	0.550		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
RA-228	0.409	0.148	0.230	0.115		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
TH-232	0.409	0.148	0.230	0.115		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
U-235	0.109	0.222	0.378	0.189	U	pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA
U-238	0.455	0.762	1.330	0.665	U	pCi/g	ARS-007/EPA 901.1M	12/09/14 11:24	JDT	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself.*
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LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03153
Client Sample ID: FS-05-03
Sample Collection Date: 11/05/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03153-002
Date Received: 11/14/14
Report Date: 12/11/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.809	0.184	0.142	0.071		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
K-40	9.460	1.526	0.918	0.459		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
TL-208	0.303	0.072	0.059	0.029		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
BI-212	0.098	0.378	0.673	0.337	U	pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
PB-212	0.779	0.140	0.132	0.066		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
BI-214	0.763	0.166	0.140	0.070		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
PB-214	0.909	0.159	0.152	0.076		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
RA-226	1.816	1.218	1.540	0.770		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
RA-228	0.809	0.184	0.142	0.071		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
TH-232	0.809	0.184	0.142	0.071		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
U-235	0.160	0.245	0.415	0.208	U	pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
U-238	1.925	0.662	1.540	0.770		pCi/g	ARS-007/EPA 901.1M	12/09/14 11:30	JDT	NA
TH-228	0.731	0.159	0.088	0.037		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	42%
TH-230	0.812	0.164	0.037	0.011		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	42%
TH-232	0.685	0.149	0.069	0.027		pCi/g	ARS-031/Eichrom ACW-10	11/21/14 21:03	BZF	42%

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03153
Client Sample ID: FS-01-BIAS
Sample Collection Date: 11/07/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03153-003
Date Received: 11/14/14
Report Date: 12/11/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	7.553	0.678	0.356	0.178		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
K-40	12.513	1.797	0.769	0.385		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
TL-208	2.397	0.277	0.156	0.078		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
BI-212	5.370	1.148	0.860	0.430		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
PB-212	8.042	0.652	0.233	0.117		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
BI-214	1.273	0.280	0.233	0.117		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
PB-214	1.555	0.304	0.266	0.133		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
RA-226	4.069	2.275	2.740	1.370		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
RA-228	7.553	0.678	0.356	0.178		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
TH-232	7.553	0.678	0.356	0.178		pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
U-235	0.234	0.472	0.788	0.394	U	pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA
U-238	1.502	2.274	3.780	1.890	U	pCi/g	ARS-007/EPA 901.1M	12/09/14 12:20	JDT	NA

NOTES:

Project Manager Review

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QC Results per Analytical Batch

Analytical Batch	ARS1-B14-03272
SDG	ARS1-14-03153
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-025
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 12/09/14 09:34 | Analysis Technician: BZF

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03272-01	LCS	AM-241	22400	1700	22748	98	670
ARS1-B14-03272-01	LCS	CO-60	40900	1600	42793	96	410
ARS1-B14-03272-01	LCS	CS-137	35300	1500	35450	100	310

Duplicate RER/DER/RPD

Analysis Date: 12/09/14 09:45 | Analysis Technician: BZF

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	22360	1702	22440	1838	0.02	0.06	0.4
CO-60	40910	1603	41990	1654	0.33	0.92	2.6
CS-137	35340	1535	37120	1621	0.56	1.56	4.9

Method Blank

Analysis Date: 12/09/14 09:27 | Analysis Technician: BZF

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03272-03	MBL	AM-241	-1	41	33	U
ARS1-B14-03272-03	MBL	CO-60	-1	20	12	U
ARS1-B14-03272-03	MBL	CS-137	0	71	18	U

LELAP Certificate# 01949

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-03010
SDG	ARS1-14-03153
Analysis	Thorium in Solid, Waste, Biota, Sediment
Analysis Test Method	ARS-031/Eichrom ACW-10
Analysis Code	ASP-A-009
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03010-01	LCS	TH-230	6.22	0.80	6.28	99	0.030

Duplicate RER/DER/RPD

Analysis Date: 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
TH-230	6.22	0.80	6.21	0.80	0.01	0.02	0.2

Method Blank

Analysis Date: 11/21/14 21:03 / 11/21/14 21:03 | Analysis Technician: AMRAD\BFORBES / AMRAD\BFORBES

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03010-03	MBL	Th-228	0.027	0.023	0.032	U
ARS1-B14-03010-03	MBL	Th-230	0.111	0.039	0.025	
ARS1-B14-03010-03	MBL	Th-232	-0.0072	0.0064	0.026	U

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Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC®** GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

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ARS INTERNATIONAL
2809 North River Road
Port Allen, LA 70767-3469
PH: (225) 381-2991
FX: (225) 381-2996
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: Li Tungsten #144036
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2809 North River Rd
Port Allen, LA 70767-3469
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	11/5/14	12:09	FS-01-05	1	S	X	X	X											
02	11/5/14	3:00	FS-05-03	1	S	X	X	X	X										
03	11/7/14	10:45	FS-01-BIAS	1	S	X	X	X											
04																			
05																			
06																			
07																			
08																			
09																			
10																			
11																			
12																			
13																			
13																			
14																			
15																			
16																			
17																			
18																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: _____ Courier: FedEx
Air Bill Number: _____
Samplers Name (Print): Allan Gumbert
Samplers Signature: _____

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

	Relinquished by	Date	Time	Received by	Date	Time
Signature		11-10-14	0900		11-14-14	1527
Printed Name	Allan J Gumbert					
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-03246

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
Perma-Fix Environmental Services, Inc.
2800 Solway Road
Knoxville, TN 37931
jhubler@perma-fix.com; elaning@perma-fix.com
swalnicki@perma-fix.com

Phone: 865-690-0501

Project Manager Review

Management Review

Notes: ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

ACLASS ACCREDITED DoD ELAP

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

January 2, 2015

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Job #: **Li Tungsten #144036**

Dear Mr. Laning;

On November 25, 2014, ARS International received 9 solid samples to be analyzed for Gamma Spectroscopy and Isotopic Thorium.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

James D. [illegible]

Laboratory Management
ARS International

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1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

**PROJECT SAMPLE IDENTIFICATION
CROSS-REFERENCE
TO ARS SAMPLE LABORATORY IDs**

Job Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
Li Tungsten #144036	FS-01-10	ARS1-14-03246-001
Li Tungsten #144036	FS-03-07	ARS1-14-03246-002
Li Tungsten #144036	FS-03-09	ARS1-14-03246-003
Li Tungsten #144036	Drum #5	ARS1-14-03246-004
Li Tungsten #144036	Drum #6	ARS1-14-03246-005
Li Tungsten #144036	Drum #7	ARS1-14-03246-006
Li Tungsten #144036	FS-01-03	ARS1-14-03246-007
Li Tungsten #144036	FS-01-02	ARS1-14-03246-008
Li Tungsten #144036	FS-01-06	ARS1-14-03246-009

ANALYTICAL METHODS

All samples were dried and ground before analysis.

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

Thorium analyses were performed using **ARS-031, "Thorium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (ACW10)".**

ANALYTICAL RESULTS

The result data that are flagged with "U" indicate that the activity is below the MDC.

American Radiation Services Project Manager/Laboratory Director's Comments:
"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

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"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

James D. Lee	Laboratory Management, ARS International	1-2-15
Signature	**Title**	**Date**

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS INTERNATIONAL

ARS Sample Delivery Group: ARS1-14-03246
Client Sample ID: FS-01-10
Sample Collection Date: 11/10/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03246-001
Date Received: 11/25/14
Report Date: 01/02/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.531	0.196	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
TH-232	0.531	0.196	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
K-40	8.825	1.418	0.524	0.262		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
TL-208	0.156	0.058	0.075	0.037		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
BI-212	0.260	0.257	0.407	0.204	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
PB-212	0.543	0.120	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
BI-214	0.495	0.124	0.107	0.054		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
PB-214	0.466	0.118	0.144	0.072		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
RA-226	1.148	0.818	1.140	0.570		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
RA-228	0.531	0.196	0.219	0.110		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA
U-235	0.093	0.199	0.340	0.170	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:01	BZF	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself.*
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LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03246
Client Sample ID: FS-03-07
Sample Collection Date: 11/20/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03246-002
Date Received: 11/25/14
Report Date: 01/02/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.421	0.193	0.261	0.131		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
TH-232	0.421	0.193	0.261	0.131		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
K-40	9.756	1.563	0.931	0.466		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
TL-208	0.200	0.064	0.063	0.032		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
BI-212	0.747	0.278	0.187	0.094		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
PB-212	0.586	0.135	0.140	0.070		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
BI-214	0.598	0.134	0.116	0.058		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
PB-214	0.677	0.149	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
RA-226	1.724	0.885	1.240	0.620		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
RA-228	0.421	0.193	0.261	0.131		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
U-235	0.112	0.213	0.368	0.184	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:04	BZF	NA
TH-228	0.676	0.129	0.029	0.009		pCi/g	ARS-031/Eichrom ACW-10	12/30/14 06:15	JH	78%
TH-230	0.589	0.115	0.020	0.005		pCi/g	ARS-031/Eichrom ACW-10	12/30/14 06:15	JH	78%
TH-232	0.527	0.107	0.028	0.009		pCi/g	ARS-031/Eichrom ACW-10	12/30/14 06:15	JH	78%

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03246
Client Sample ID: FS-03-09
Sample Collection Date: 11/20/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03246-003
Date Received: 11/25/14
Report Date: 01/02/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.725	0.181	0.141	0.071		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
TH-232	0.725	0.181	0.141	0.071		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
K-40	9.253	1.494	0.499	0.250		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
TL-208	0.243	0.070	0.062	0.031		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
BI-212	0.252	0.332	0.561	0.281	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
PB-212	0.684	0.135	0.117	0.059		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
BI-214	0.592	0.129	0.097	0.049		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
PB-214	0.448	0.118	0.146	0.073		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
RA-226	0.857	1.048	1.450	0.725	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
RA-228	0.725	0.181	0.141	0.071		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA
U-235	0.098	0.241	0.414	0.207	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:07	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

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ARS INTERNATIONAL

ARS Sample Delivery Group: ARS1-14-03246
Client Sample ID: drum #5
Sample Collection Date: 11/21/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03246-004
Date Received: 11/25/14
Report Date: 01/02/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	9.606	0.807	0.393	0.197		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
TH-232	9.606	0.807	0.393	0.197		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
K-40	10.314	1.741	1.120	0.560		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
TL-208	3.487	0.338	0.150	0.075		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
BI-212	6.749	1.625	1.280	0.640		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
PB-212	10.391	0.809	0.260	0.130		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
BI-214	4.839	0.520	0.290	0.145		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
PB-214	5.192	0.609	0.318	0.159		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
RA-226	9.817	2.901	3.360	1.680		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
RA-228	9.606	0.807	0.393	0.197		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA
U-235	0.366	0.635	1.050	0.525	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:33	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-03246
Client Sample ID: drum #6
Sample Collection Date: 11/21/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03246-005
Date Received: 11/25/14
Report Date: 01/02/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	11.114	1.026	0.436	0.218		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
TH-232	11.114	1.026	0.436	0.218		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
K-40	9.818	2.109	1.420	0.710		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
TL-208	3.641	0.345	0.152	0.076		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
BI-212	8.828	1.566	1.140	0.570		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
PB-212	12.399	0.936	0.253	0.127		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
BI-214	3.641	0.475	0.306	0.153		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
PB-214	4.366	0.546	0.312	0.156		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
RA-226	7.594	3.329	3.600	1.800		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
RA-228	11.114	1.026	0.436	0.218		pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA
U-235	0.653	0.809	0.969	0.485	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 13:08	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
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ARS INTERNATIONAL

ARS Sample Delivery Group:	ARS1-14-03246	**Request or PO Number:**	Li Tungsten #144036
Client Sample ID:	drum #7	**ARS Sample ID:**	ARS1-14-03246-006
Sample Collection Date:	11/21/14	**Date Received:**	11/25/14
Sample Matrix:	Soil/Solid/Sludge	**Report Date:**	01/02/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	11.844	1.073	0.167	0.084		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
TH-232	11.844	1.073	0.167	0.084		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
K-40	8.072	1.445	0.932	0.466		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
TL-208	4.408	0.404	0.175	0.088		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
BI-212	8.713	1.366	0.979	0.490		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
PB-212	13.635	1.009	0.280	0.140		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
BI-214	2.032	0.370	0.308	0.154		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
PB-214	2.396	0.340	0.315	0.158		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
RA-226	3.134	2.469	3.270	1.635	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
RA-228	11.844	1.073	0.167	0.084		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA
U-235	0.077	0.680	1.150	0.575	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:37	BZF	NA

NOTES:

Project Manager Review

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ARS INTERNATIONAL

ARS Sample Delivery Group: ARS1-14-03246
Client Sample ID: FS-01-03
Sample Collection Date: 11/24/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03246-007
Date Received: 11/25/14
Report Date: 01/02/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.348	0.182	0.254	0.127		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
TH-232	0.348	0.182	0.254	0.127		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
K-40	8.417	1.366	0.459	0.230		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
TL-208	0.195	0.050	0.041	0.021		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
BI-212	0.134	0.309	0.550	0.275	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
PB-212	0.485	0.130	0.127	0.064		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
BI-214	0.413	0.114	0.104	0.052		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
PB-214	0.461	0.124	0.138	0.069		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
RA-226	1.922	1.120	1.250	0.625		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
RA-228	0.348	0.182	0.254	0.127		pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA
U 235	-0.052	0.581	0.380	0.190	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 10:40	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-03246
Client Sample ID: FS-01-02
Sample Collection Date: 11/24/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03246-008
Date Received: 11/25/14
Report Date: 01/02/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.574	0.152	0.094	0.047		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
TH-232	0.574	0.152	0.094	0.047		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
K-40	7.496	1.258	0.847	0.424		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
TL-208	0.165	0.056	0.051	0.025		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
BI-212	0.158	0.292	0.503	0.252	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
PB-212	0.469	0.101	0.094	0.047		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
BI-214	0.532	0.125	0.091	0.045		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
PB-214	0.409	0.099	0.130	0.065		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
RA-226	0.941	0.772	1.280	0.640	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
RA-228	0.574	0.152	0.094	0.047		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA
U-235	-0.046	0.514	0.323	0.162	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 11:05	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-03246
Client Sample ID: FS-01-06
Sample Collection Date: 11/24/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03246-009
Date Received: 11/25/14
Report Date: 01/02/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.504	0.172	0.193	0.097		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
TH-232	0.504	0.172	0.193	0.097		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
K-40	9.414	1.509	0.556	0.278		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
TL-208	0.189	0.056	0.050	0.025		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
BI-212	0.981	0.452	0.422	0.211		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
PB-212	0.660	0.123	0.107	0.054		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
BI-214	0.394	0.126	0.156	0.078		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
PB-214	0.589	0.131	0.131	0.066		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
RA-226	1.589	0.859	1.120	0.560		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
RA-228	0.504	0.172	0.193	0.097		pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA
U-235	0.152	0.213	0.357	0.179	U	pCi/g	ARS-007/EPA 901.1M	12/17/14 11:08	BZF	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

ARS INTERNATIONAL

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-03531
SDG	ARS1-14-03246
Analysis	Thorium in Solid, Waste, Biota, Sediment
Analysis Test Method	ARS-031/Eichrom ACW-10
Analysis Code	ASP-A-009
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 12/30/14 06:15 | Analysis Technician: AMRAD\JHOLLIDAY

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03531-01	LCS	TH-230	5.84	0.76	6.27	93	0.035

Duplicate RER/DER/RPD

Analysis Date: 12/30/14 06:15 | Analysis Technician: AMRAD\JHOLLIDAY

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
TH-230	5.84	0.76	5.54	0.72	0.20	0.56	5.3

Method Blank

Analysis Date: 12/30/14 06:15 12/30/14 06:15 | Analysis Technician: AMRAD\JHOLLIDAY AMRAD\JHOLLIDAY

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03531-03	MBL	TH-228	0.039	0.024	0.022	
ARS1-B14-03531-03	MBL	TH-230	0.091	0.037	0.027	
ARS1-B14-03531-03	MBL	TH-232	0.005	0.015	0.029	U

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ARS INTERNATIONAL

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-03453
SDG	ARS1-14-03246
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-025
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 12/17/14 08:05 | Analysis Technician: BZF

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03453-01	LCS	AM-241	22300	1700	22748	98	660
ARS1-B14-03453-01	LCS	CO-60	40800	1600	42793	95	390
ARS1-B14-03453-01	LCS	CS-137	35200	1500	35450	99	300

Duplicate RER/DER/RPD

Analysis Date: 12/17/14 08:19 | Analysis Technician: BZF

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	22350	1731	21860	1669	0.14	0.40	2.2
CO-60	40750	1586	41760	1636	0.31	0.87	2.4
CS-137	35170	1538	35370	1534	0.07	0.18	0.6

Method Blank

Analysis Date: 12/17/14 08:37 | Analysis Technician: PKC

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03453-03	MBL	AM-241	3	14	26	U
ARS1-B14-03453-03	MBL	CO-60	0	27	23	U
ARS1-B14-03453-03	MBL	CS-137	5	12	22	U

LELAP Certificate# 01949

ARS INTERNATIONAL
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Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC**® GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

Notes: ARS International assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

LELAP Cert# 01949 ***NELAP Cert# E87558***

ARS INTERNATIONAL
2609 North River Road
Port Allen, LA 70767-3489
PH: (225) 381-2991
FX: (225) 381-2998
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: Li Tungsten #144036
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3489
Phone: (225) 381-2991
Fax: (225) 381-2998
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	11/10/14	2:15	FS-01-10	1	S	X	X	X											
02	11/20/14	1:20	FS-03-07	1	S	X	X	X	X										
03	11/20/14	1:15	FS-03-09	1	S	X	X	X											
04	11/21/14	8:00	drum #5	1	S	X	X	X											
05	11/21/14	8:30	drum #6	1	S	X	X	X											
06	11/21/14	8:15	drum #7	1	S	X	X	X											
07	11/24/14	11:00	FS-01-03	1	S	X	X	X											
08	11/24/14	11:10	FS-01-02	1	S	X	X	X											
09	11/24/14	11:30	FS-01-06	1	S	X	X	X											
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: 11-24-14 12:00pm
Courier: FedEx
Air Bill Number: 771469936976
Samplers Name (Print): Allan Gumbert
Samplers Signature: _____

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

	Relinquished by	Date	Time	Received by	Date	Time
Signature	_____	11-24-14	12:04pm	_____	11-25-14	1158
Printed Name	Allan J Gumbert					
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-03455

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
Perma-Fix Environmental Services, Inc.
2800 Solway Road
Knoxville, TN 37931
jhubler@perma-fix.com; elaning@perma-fix.com
swalnicki@perma-fix.com

Phone: 865-690-0501

Project Manager Review

Management Review

Notes: ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

January 16, 2015

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Job #: **Li Tungsten #144036**

Dear Mr. Laning;

On December 9, 2014, ARS International received 4 solid samples to be analyzed for Gamma Spectroscopy and Isotopic Thorium.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

James D. Rue

Laboratory Management
ARS International

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

**PROJECT SAMPLE IDENTIFICATION
CROSS-REFERENCE
TO ARS SAMPLE LABORATORY IDs**

Job Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
Li Tungsten #144036	FS-01-09	ARS1-14-03455-001
Li Tungsten #144036	FS-03-10	ARS1-14-03455-002
Li Tungsten #144036	FS-03-03	ARS1-14-03455-003
Li Tungsten #144036	FS-03-05	ARS1-14-03455-004

ANALYTICAL METHODS

All samples were dried and ground before analysis.

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

Thorium analyses were performed using **ARS-031, "Thorium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (ACW10)".**

ANALYTICAL RESULTS

The result data that are flagged with "U" indicate that the activity is below the MDC.

American Radiation Services Project Manager/Laboratory Director's Comments:
"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

Signature	Title	Date
James D. Rue	Laboratory Management, ARS International	01-16-15

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03455
Client Sample ID: FS-01-09
Sample Collection Date: 12/03/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03455-001
Date Received: 12/09/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.021	0.200	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA
K-40	10.222	1.450	0.788	0.394		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA
BI-212	1.007	0.371	0.283	0.142		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA
PB-212	1.067	0.149	0.107	0.054		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA
BI-214	1.007	0.164	0.092	0.046		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA
PB-214	0.975	0.151	0.148	0.074		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA
RA-226	2.539	1.162	1.310	0.655		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA
RA-228	1.021	0.200	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA
TH-232	1.021	0.200	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA
U-235	-0.003	0.347	0.432	0.216	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:50	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03455
Client Sample ID: FS-03-10
Sample Collection Date: 12/04/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03455-002
Date Received: 12/09/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.688	0.150	0.149	0.075		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
K-40	6.885	1.255	0.595	0.298		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
BI-212	0.165	0.331	0.577	0.289	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
PB-212	0.531	0.126	0.127	0.064		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
BI-214	0.341	0.117	0.149	0.075		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
PB-214	0.469	0.117	0.118	0.059		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
RA-226	0.889	0.706	1.190	0.595	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
RA-228	0.688	0.150	0.149	0.075		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
TH-232	0.688	0.150	0.149	0.075		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
U-235	0.166	0.196	0.324	0.162	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:51	WJS	NA
TH-228	0.525	0.113	0.012	0.000		pCi/g	ARS-031/Eichrom ACW-10	12/30/14 06:15	JH	72%
TH-230	0.549	0.116	0.042	0.016		pCi/g	ARS-031/Eichrom ACW-10	12/30/14 06:15	JH	72%
TH-232	0.482	0.107	0.042	0.016		pCi/g	ARS-031/Eichrom ACW-10	12/30/14 06:15	JH	72%

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03455
Client Sample ID: FS-03-03
Sample Collection Date: 12/04/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03455-003
Date Received: 12/09/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.262	0.144	0.201	0.101		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA
K-40	5.388	1.006	0.404	0.202		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA
BI-212	-0.035	8.742	0.516	0.258	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA
PB-212	0.364	0.085	0.084	0.042		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA
BI-214	0.424	0.110	0.095	0.047		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA
PB-214	0.348	0.097	0.120	0.060		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA
RA-226	1.012	0.719	0.989	0.495		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA
RA-228	0.262	0.144	0.201	0.101		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA
TH-232	0.262	0.144	0.201	0.101		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA
U-235	0.082	0.173	0.296	0.148	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:52	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03455
Client Sample ID: FS-03-05
Sample Collection Date: 12/04/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03455-004
Date Received: 12/09/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.953	0.202	0.075	0.038		pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA
K-40	11.230	1.537	0.298	0.149		pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA
BI-212	0.583	0.390	0.475	0.238		pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA
PB-212	0.919	0.128	0.092	0.046		pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA
BI-214	0.687	0.135	0.072	0.036		pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA
PB-214	0.794	0.167	0.134	0.067		pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA
RA-226	1.080	1.240	1.430	0.715	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA
RA-228	0.953	0.202	0.075	0.038		pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA
TH-232	0.953	0.202	0.075	0.038		pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA
U-235	0.000	0.114	0.390	0.195	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 11:24	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

ARS INTERNATIONAL

QC Results per Analytical Batch

Analytical Batch	ARS1-B15-00029
SDG	ARS1-14-03442
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-025
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

			Analysis Date	01/12/15 08:25	Analysis Technician	WJS	
Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B15-00029-01	LCS	AM-241	22300	1700	22748	98	650
ARS1-B15-00029-01	LCS	CO-60	42600	1700	42793	100	360
ARS1-B15-00029-01	LCS	CS-137	36200	1600	35450	102	300

Duplicate RER/DER/RPD

			Analysis Date	01/12/15 08:37	Analysis Technician	WJS	
Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	22250	1726	21960	1803	0.08	0.23	1.3
CO-60	42570	1686	42050	1647	0.16	0.43	1.2
CS-137	36200	1570	37760	1798	0.46	1.28	4.2

Method Blank

			Analysis Date	01/12/15 08:26	Analysis Technician	WJS	
Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual	
ARS1-B15-00029-03	MBL	AM-241	7	15	26	U	
ARS1-B15-00029-03	MBL	CO-60	0.0	3.6	13	U	
ARS1-B15-00029-03	MBL	CS-137	3.6	9.6	18	U	

LELAP Certificate# 01949

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-03531
SDG	ARS1-14-03455
Analysis	Thorium in Solid, Waste, Biota, Sediment
Analysis Test Method	ARS-031/Eichrom ACW-10
Analysis Code	ASP-A-009
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 12/30/14 06:15 | Analysis Technician: AMRAD\JHOLLIDAY

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03531-01	LCS	TH-230	5.84	0.76	6.27	93	0.035

Duplicate RER/DER/RPD

Analysis Date: 12/30/14 06:15 | Analysis Technician: AMRAD\JHOLLIDAY

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
TH-230	5.84	0.76	5.54	0.72	0.20	0.56	5.3

Method Blank

Analysis Date: 12/30/14 06:15, 12/30/14 06:15 | Analysis Technician: AMRAD\JHOLLIDAY, AMRAD\JHOLLIDAY

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03531-03	MBL	TH-228	0.039	0.024	0.022	
ARS1-B14-03531-03	MBL	TH-230	0.091	0.037	0.027	
ARS1-B14-03531-03	MBL	TH-232	0.005	0.015	0.029	U

Notes: American Radiation Services, Inc. assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

LELAP Certificate# 01949

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC**® GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

LELAP Cert# 01949 ***NELAP Cert# E87558***

ARS INTERNATIONAL
2609 North River Road
Port Allen, LA 70767-3469
PH: (225) 381-2991
FX: (225) 381-2996
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: Li Tungsten #144036
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3469
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	12/3/14	1:20	FS-01-09	1	S	X	X	X											
02	12/4/14	8:25	FS-03-10	1	S	X	X	X	X										
03	12/4/14	2:17	FS-03-03	1	S	X	X	X											
04	12/4/14	2:15	FS-03-05	1	S	X	X	X											
05																			
06																			
07																			
08																			
09																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: 12-8-14 0900
Courier: FedEx
Air Bill Number: 772125811380

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

Samplers Name (Print): Allan Gumbert
Samplers Signature: _____

	Relinquished by	Date	Time	Received by	Date	Time
Signature		12-8-14	0900		12-9-14	1510
Printed Name	Allan J Gumbert					
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-03442

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
Perma-Fix Environmental Services, Inc.
2800 Solway Road
Knoxville, TN 37931
jhubler@perma-fix.com; elaning@perma-fix.com
swalnicki@perma-fix.com

Phone: 865-690-0501

Susan Reese
Project Manager Review

James D. Lee
Management Review

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

January 16, 2015

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Job #: **Li Tungsten #144036**

Dear Mr. Laning;

On December 8, 2014, ARS International received fourteen (14) solid samples to be analyzed for Gamma Spectroscopy and Isotopic Thorium.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

James D. Pen

Laboratory Management
ARS International

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

**PROJECT SAMPLE IDENTIFICATION
CROSS-REFERENCE
TO ARS SAMPLE LABORATORY IDs**

Job Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
Li Tungsten #144036	FS01-S01	ARS1-14-03442-001
Li Tungsten #144036	FS01-S02	ARS1-14-03442-002
Li Tungsten #144036	FS01-S03	ARS1-14-03442-003
Li Tungsten #144036	FS01-S04	ARS1-14-03442-004
Li Tungsten #144036	FS01-S05	ARS1-14-03442-005
Li Tungsten #144036	FS01-S06	ARS1-14-03442-006
Li Tungsten #144036	FS01-S07	ARS1-14-03442-007
Li Tungsten #144036	FS01-S08	ARS1-14-03442-008
Li Tungsten #144036	FS01-S09	ARS1-14-03442-009
Li Tungsten #144036	FS01-S10	ARS1-14-03442-010
Li Tungsten #144036	FS01-NP1	ARS1-14-03442-011
Li Tungsten #144036	FS01-NP2	ARS1-14-03442-012
Li Tungsten #144036	FS03-BIAS1	ARS1-14-03442-013
Li Tungsten #144036	FS03-BIAS2	ARS1-14-03442-014

ANALYTICAL METHODS

All samples were dried and ground before analysis.

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

Thorium analyses were performed using **ARS-031, "Thorium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (ACW10)".**

ARS INTERNATIONAL
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1 (800) 401-4277 • Fax (225) 381-2996

ANALYTICAL RESULTS
The result data that are flagged with "U" indicate that the activity is below the MDC.

American Radiation Services Project Manager/Laboratory Director's Comments:
"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

James D. Rue	Laboratory Management, ARS International	01-16-15
Signature	**Title**	**Date**

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S01
Sample Collection Date: 12/02/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-001
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.530	0.169	0.162	0.081		pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA
K-40	8.835	1.399	0.606	0.303		pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA
BI-212	0.310	0.330	0.539	0.270	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA
PB-212	0.487	0.101	0.096	0.048		pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA
BI-214	0.351	0.108	0.129	0.065		pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA
PB-214	0.488	0.130	0.126	0.063		pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA
RA-226	1.149	0.977	1.290	0.645	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA
RA-228	0.530	0.169	0.162	0.081		pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA
TH-232	0.530	0.169	0.162	0.081		pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA
U-235	-0.023	0.923	0.412	0.206	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 08:29	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S02
Sample Collection Date: 12/02/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-002
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.521	0.339	0.240	0.120		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
K-40	10.193	1.492	0.320	0.160		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
BI-212	0.942	0.587	0.563	0.282		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
PB-212	1.377	0.173	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
BI-214	1.120	0.198	0.113	0.057		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
PB-214	1.481	0.239	0.163	0.082		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
RA-226	3.732	1.273	1.280	0.640		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
RA-228	1.521	0.339	0.240	0.120		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
TH-232	1.521	0.339	0.240	0.120		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
U-235	0.279	0.356	0.432	0.216	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:01	WJS	NA
TH-228	0.776	0.137	0.028	0.010		pCi/g	ARS-031/Eichrom ACW-10	12/11/14 17:21	JH	88%
TH-230	0.756	0.136	0.047	0.019		pCi/g	ARS-031/Eichrom ACW-10	12/11/14 17:21	JH	88%
TH-232	0.853	0.147	0.032	0.011		pCi/g	ARS-031/Eichrom ACW-10	12/11/14 17:21	JH	88%

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S03
Sample Collection Date: 12/02/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-003
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.343	0.168	0.225	0.113		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA
K-40	6.082	1.144	0.987	0.494		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA
BI-212	0.620	0.235	0.156	0.078		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA
PB-212	0.543	0.092	0.073	0.037		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA
BI-214	0.355	0.109	0.130	0.065		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA
PB-214	0.492	0.132	0.112	0.056		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA
RA-226	0.881	0.683	1.130	0.565	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA
RA-228	0.343	0.168	0.225	0.113		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA
TH-232	0.343	0.168	0.225	0.113		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA
U-235	0.087	0.181	0.309	0.155	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:03	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S04
Sample Collection Date: 12/02/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-004
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.849	0.233	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA
K-40	9.820	1.635	0.634	0.317		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA
BI-212	0.991	0.351	0.220	0.110		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA
PB-212	0.800	0.160	0.150	0.075		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA
BI-214	0.699	0.160	0.131	0.066		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA
PB-214	0.704	0.156	0.167	0.084		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA
RA-226	2.041	1.309	1.580	0.790		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA
RA-228	0.849	0.233	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA
TH-232	0.849	0.233	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA
U-235	0.082	0.256	0.443	0.222	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:06	WJS	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself.*
Reproduction of this report in less than full requires the written consent of ARS International, LLC.
The results in this report pertain only to the samples tested and are intended solely for the use of the client.

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S05
Sample Collection Date: 12/02/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-005
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.279	0.209	0.326	0.163	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA
K-40	7.431	1.326	0.504	0.252		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA
BI-212	0.012	0.380	0.705	0.353	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA
PB-212	0.577	0.138	0.133	0.067		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA
BI-214	0.188	0.100	0.149	0.075		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA
PB-214	0.518	0.119	0.128	0.064		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA
RA-226	1.360	1.257	1.500	0.750	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA
RA-228	0.279	0.209	0.326	0.163	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA
TH-232	0.279	0.209	0.326	0.163	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA
U-235	0.142	0.201	0.338	0.169	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:04	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S06
Sample Collection Date: 12/02/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-006
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.763	0.200	0.122	0.061		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA
K-40	12.012	1.586	0.290	0.145		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA
BI-212	-0.010	0.681	0.732	0.366	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA
PB-212	0.765	0.118	0.098	0.049		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA
BI-214	0.906	0.144	0.046	0.023		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA
PB-214	1.004	0.180	0.104	0.052		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA
RA-226	1.396	1.116	1.260	0.630		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA
RA-228	0.763	0.200	0.122	0.061		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA
TH-232	0.763	0.200	0.122	0.061		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA
U-235	0.166	0.299	0.369	0.185	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:37	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S07
Sample Collection Date: 12/02/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-007
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.654	0.148	0.210	0.105		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA
K-40	8.662	1.298	0.760	0.380		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA
BI-212	0.152	0.280	0.481	0.241	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA
PB-212	0.676	0.127	0.112	0.056		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA
BI-214	0.633	0.135	0.102	0.051		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA
PB-214	0.652	0.117	0.126	0.063		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA
RA-226	1.030	0.809	1.330	0.665	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA
RA-228	0.654	0.148	0.210	0.105		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA
TH-232	0.654	0.148	0.210	0.105		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA
U-235	-0.109	0.286	0.340	0.170	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:38	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S08
Sample Collection Date: 12/03/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-008
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.101	0.252	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA
K-40	11.090	1.754	0.635	0.318		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA
BI-212	0.372	0.437	0.719	0.360	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA
PB-212	1.131	0.174	0.143	0.072		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA
BI-214	0.983	0.227	0.194	0.097		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA
PB-214	1.219	0.197	0.194	0.097		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA
RA-226	2.087	1.475	1.790	0.895		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA
RA-228	1.101	0.252	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA
TH-232	1.101	0.252	0.176	0.088		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA
U-235	0.016	0.280	0.490	0.245	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:39	WJS	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S09
Sample Collection Date: 12/03/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-009
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.401	0.153	0.246	0.123		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA
K-40	8.225	1.331	0.446	0.223		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA
BI-212	0.247	0.335	0.565	0.283	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA
PB-212	0.530	0.107	0.101	0.051		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA
BI-214	0.443	0.131	0.121	0.061		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA
PB-214	0.531	0.116	0.142	0.071		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA
RA-226	0.727	0.795	1.370	0.685	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA
RA-228	0.401	0.153	0.246	0.123		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA
TH-232	0.401	0.153	0.246	0.123		pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA
U-235	0.174	0.197	0.325	0.163	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 09:40	WJS	NA

NOTES:

Project Manager Review

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ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-S10
Sample Collection Date: 12/03/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-010
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.748	0.257	0.224	0.112		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA
K-40	12.312	1.592	0.282	0.141		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA
BI-212	0.921	0.277	0.148	0.074		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA
PB-212	0.882	0.122	0.085	0.042		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA
BI-214	0.877	0.161	0.098	0.049		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA
PB-214	0.838	0.182	0.125	0.063		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA
RA-226	0.583	1.237	1.460	0.730	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA
RA-228	0.748	0.257	0.224	0.112		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA
TH-232	0.748	0.257	0.224	0.112		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA
U-235	0.005	0.296	0.375	0.188	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:13	WJS	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-NP1
Sample Collection Date: 12/03/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-011
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.681	0.159	0.259	0.130		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA
K-40	9.118	1.473	1.130	0.565		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA
BI-212	1.045	0.414	0.360	0.180		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA
PB-212	0.915	0.150	0.120	0.060		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA
BI-214	0.749	0.155	0.158	0.079		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA
PB-214	1.059	0.193	0.131	0.066		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA
RA-226	2.371	1.383	1.500	0.750		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA
RA-228	0.681	0.159	0.259	0.130		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA
TH-232	0.681	0.159	0.259	0.130		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA
U-235	0.085	0.231	0.397	0.199	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:14	WJS	NA

NOTES:

Project Manager Review

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ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS01-NP2
Sample Collection Date: 12/03/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-012
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	0.456	0.153	0.258	0.129		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA
K-40	6.928	1.243	0.530	0.265		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA
BI-212	0.241	0.315	0.526	0.263	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA
PB-212	0.562	0.124	0.119	0.060		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA
BI-214	0.406	0.131	0.131	0.066		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA
PB-214	0.504	0.105	0.122	0.061		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA
RA-226	0.771	0.782	1.330	0.665	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA
RA-228	0.456	0.153	0.258	0.129		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA
TH-232	0.456	0.153	0.258	0.129		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA
U-235	-0.026	4.862	0.337	0.169	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:15	WJS	NA

NOTES:

Project Manager Review

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ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS03-BIAS1
Sample Collection Date: 12/04/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-013
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.998	0.300	0.163	0.082		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA
K-40	6.151	1.159	0.753	0.377		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA
BI-212	1.298	0.444	0.401	0.201		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA
PB-212	1.721	0.189	0.117	0.059		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA
BI-214	0.361	0.122	0.159	0.080		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA
PB-214	0.716	0.188	0.154	0.077		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA
RA-226	1.143	1.023	1.700	0.850	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA
RA-228	1.998	0.300	0.163	0.082		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA
TH-232	1.998	0.300	0.163	0.082		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA
U-235	0.124	0.280	0.474	0.237	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:16	WJS	NA

NOTES:

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ARS Sample Delivery Group: ARS1-14-03442
Client Sample ID: FS03-BIAS2
Sample Collection Date: 12/04/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: Li Tungsten #144036
ARS Sample ID: ARS1-14-03442-014
Date Received: 12/08/14
Report Date: 01/16/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	3.147	0.366	0.174	0.087		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
K-40	6.228	1.017	0.425	0.213		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
BI-212	2.487	0.584	0.412	0.206		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
PB-212	3.435	0.289	0.108	0.054		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
BI-214	0.312	0.154	0.152	0.076		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
PB-214	0.423	0.120	0.138	0.069		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
RA-226	1.072	1.284	1.480	0.740	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
RA-228	3.147	0.366	0.174	0.087		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
TH-232	3.147	0.366	0.174	0.087		pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
U-235	0.000	0.122	0.491	0.246	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 10:48	WJS	NA
TH-228	0.464	0.099	0.030	0.010		pCi/g	ARS-031/Eichrom ACW-10	12/11/14 17:21	JH	75%
TH-230	0.213	0.063	0.045	0.018		pCi/g	ARS-031/Eichrom ACW-10	12/11/14 17:21	JH	75%
TH-232	0.477	0.099	0.020	0.005		pCi/g	ARS-031/Eichrom ACW-10	12/11/14 17:21	JH	75%

NOTES:

Project Manager Review

LELAP Certificate# 01949

Analytical Batch	ARS1-B14-03278
SDG	ARS1-14-03442
Analysis	Thorium in Solid, Waste, Biota, Sediment
Analysis Test Method	ARS-031/Eichrom ACW-10
Analysis Code	ASP-A-009
Report Units	pCi/g

QC Results per Analytical Batch

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date	12/11/14 17:21	Analysis Technician	AMRAD\JHOLLIDAY		

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-03278-01	LCS	TH-230	5.51	0.72	6.29	88	0.034

Duplicate RER/DER/RPD

Analysis Date	12/11/14 17:21	Analysis Technician	AMRAD\JHOLLIDAY				

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
TH-230	5.51	0.72	5.66	0.73	0.10	0.29	2.7

Method Blank

Analysis Date	12/11/14 17:21 12/11/14 17:21	Analysis Technician	AMRAD\JHOLLIDAY AMRAD\JHOLLIDAY			

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-03278-03	MBL	TH-228	0.020	0.018	0.020	
ARS1-B14-03278-03	MBL	TH-230	0.016	0.021	0.033	U
ARS1-B14-03278-03	MBL	TH-232	0.009	0.013	0.020	U

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QC Results per Analytical Batch

Analytical Batch	ARS1-B15-00029
SDG	ARS1-14-03455
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-025
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 01/12/15 08:25 | Analysis Technician: WJS

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B15-00029-01	LCS	AM-241	22300	1700	22748	98	650
ARS1-B15-00029-01	LCS	CO-60	42600	1700	42793	100	360
ARS1-B15-00029-01	LCS	CS-137	36200	1600	35450	102	300

Duplicate RER/DER/RPD

Analysis Date: 01/12/15 08:37 | Analysis Technician: WJS

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	22250	1726	21960	1803	0.08	0.23	1.3
CO-60	42570	1686	42050	1647	0.16	0.43	1.2
CS-137	36200	1570	37760	1798	0.46	1.28	4.2

Method Blank

Analysis Date: 01/12/15 08:26 | Analysis Technician: WJS

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B15-00029-03	MBL	AM-241	7	15	26	U
ARS1-B15-00029-03	MBL	CO-60	0.0	3.6	13	U
ARS1-B15-00029-03	MBL	CS-137	3.6	9.6	18	U

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Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC**® GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

Notes: ARS International assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

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ARS INTERNATIONAL
2609 North River Road
Port Allen, LA 70767-3489
PH: (225) 381-2991
FX: (225) 381-2996
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931

Phone #: (865)690-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnicki@perma-fix.com

Purchase Order: _____
Job #: LI Tungsten #144036
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3489
Phone: (225) 381-2991
Fax: (225) 381-2996
Email: ProjectManagers@amrad.com

SAMPLE No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec: Bi-214, Pb-214, Ra-226	Gamma Spec: Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	12/2/14	8:10	FS01-S01	1	S	X	X	X											
02	12/2/14	8:45	FS01-S02	1	S	X	X	X	X										
03	12/2/14	9:50	FS01-S03	1	S	X	X	X											
04	12/2/14	9:15	FS01-S04	1	S	X	X	X											
05	12/2/14	10:18	FS01-S05	1	S	X	X	X											
06	12/2/14	11:40	FS01-S06	1	S	X	X	X											
07	12/2/14	12:20	FS01-S07	1	S	X	X	X											
08	12/3/14	8:30	FS01-S08	1	S	X	X	X											
09	12/3/14	9:00	FS01-S09	1	S	X	X	X											
10	12/3/14	9:50	FS01-S10	1	S	X	X	X											
11	12/3/14	9:10	FS01-NP1	1	S	X	X	X											
12	12/3/14	9:20	FS01-NP2	1	S	X	X	X											
13	12/4/14	2:06	FS03-BIAS1	1	S	X	X	X											
14	12/4/14	2:02	FS03-BIAS2	1	S	X	X	X	X										
15																			
16																			
17																			
18																			
19																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: 12-5-14 0930
Courier: FedEx
Air Bill Number: 7721 0510 0988

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-228
21 day ingrowth

Samplers Name (Print): Allan Gumbert
Samplers Signature: _____

	Relinquished by	Date	Time	Received by	Date	Time
Signature		12/5/14	0930		12-8-14	1258
Printed Name	Allan J Gumbert					
Signature						
Printed Name						

* Types of sample: S: solids/soil | L: liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bio: Bioassay | Sludge

2609 North River Road, Port Allen, Louisiana 70767

(800) 401-4277 -- FAX (225) 381-2996

ARS International, LLC

Laboratory Analysis Report

ARS1-14-03569

Prepared for:

Perma-Fix Environmental Services, Inc.

Eric Laning
Perma-Fix Environmental Services, Inc.
2800 Solway Road
Knoxville, TN 37931
jhubler@perma-fix.com; elaning@perma-fix.com
swalnicki@perma-fix.com

Phone: 865-690-0501

Susan Reese
Project Manager Review

James D. Law
Management Review

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

ACLASS ACCREDITED DoD ELAP

LELAP Cert# 01949

ARS INTERNATIONAL

2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

January 20, 2015

Perma-Fix Environmental Services
Eric Laning
2800 Solway Road
Knoxville, TN 37931

Job #: **Li Tungsten #144036**

Dear Mr. Laning;

On December 19, 2014, ARS International received 3 solid samples to be analyzed for Gamma Spectroscopy.

The samples were processed and counted using the appropriate counting equipment and QA/QC for this type of analysis. Results of the analysis and QA/QC are attached in the data package.

The client and QA/QC samples were counted with a count time sufficient to meet quality control parameters for counting equipment and were within acceptance criteria and statistical sound detection limits.

If you have any questions please do not hesitate to call at 225.381.2991 or email ProjectManagers@amrad.com.

Sincerely,

Laboratory Management
ARS International

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

COVER PAGE

**PROJECT SAMPLE IDENTIFICATION
CROSS-REFERENCE
TO ARS SAMPLE LABORATORY IDs**

Job Number	Perma-Fix PROJECT SAMPLE ID NUMBER	American Radiation Services SAMPLE ID NUMBER(S)
Li Tungsten #144036	FS-01-BIAS HOLE	ARS1-14-03569-001
Li Tungsten #144036	FS-01-COMP STOCKPILE	ARS1-14-03569-002
Li Tungsten #144036	FS-03-B03-BIAS	ARS1-14-03569-003

ANALYTICAL METHODS

All samples were dried and ground before analysis.

The Gamma Spec determinations for solids were performed using **ARS-007, "Modified Gamma Emitting Radionuclides in Water, Soil, Air and Biota Matrices**. This method utilizes a High Purity Germanium N-type detector capable of measuring in the range of 5 to 2000 KeV. Solid samples were prepped in tuna cans, and after a 21day ingrowth period, were counted for 1800 live seconds.

ANALYTICAL RESULTS

The result data that are flagged with "U" indicate that the activity is below the MDC.

American Radiation Services Project Manager/Laboratory Director's Comments:
"I certify that this sample data package is in compliance with SOW requirements, both technically and for completeness, other than the conditions detailed above. Release of the data contained in this sample data package and the computer-readable EDD, as applicable, submitted on diskette or by modem, has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature."

"I certify that this electronic image and all hardcopies produced from this image accurately represent the data and is in compliance with client specific requirements, both technically and for completeness, other than the conditions detailed above or in the sample data package narrative. Release, by submission through email, the data contained in this electronic image and the computer-readable EDD (as applicable), has been authorized by the laboratory Manager/Technical Director or the Manager's designee."

James D [illegible]	Laboratory Management, ARS International	01-20-15
Signature	**Title**	**Date**

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03569
Client Sample ID: FS-01-BIAS HOLE
Sample Collection Date: 12/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: NA
ARS Sample ID: ARS1-14-03569-001
Date Received: 12/19/14
Report Date: 01/20/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.292	0.243	0.278	0.139		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
K-40	13.723	1.959	1.070	0.535		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
BI-212	0.904	0.399	0.384	0.192		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
PB-212	1.434	0.249	0.215	0.108		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
BI-214	1.484	0.267	0.177	0.089		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
PB-214	1.557	0.234	0.184	0.092		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
RA-226	3.198	1.925	2.090	1.045		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
RA-228	1.292	0.243	0.278	0.139		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
TH-232	1.292	0.243	0.278	0.139		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
U-235	-0.030	1.191	0.715	0.358	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-03569
Client Sample ID: FS-01-COMP STOCKPILE
Sample Collection Date: 12/18/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: NA
ARS Sample ID: ARS1-14-03569-002
Date Received: 12/19/14
Report Date: 01/20/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	2.712	0.332	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
K-40	11.674	1.752	0.590	0.295		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
BI-212	1.756	0.602	0.482	0.241		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
PB-212	2.594	0.267	0.169	0.085		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
BI-214	0.881	0.189	0.183	0.092		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
PB-214	1.027	0.213	0.192	0.096		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
RA-226	2.758	1.409	1.720	0.860		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
RA-228	2.712	0.332	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
TH-232	2.712	0.332	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA
U-235	-0.030	12.072	0.536	0.268	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 12:07	WJS	NA

NOTES:

Project Manager Review

Notes: *ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of ARS International, LLC. The results in this report pertain only to the samples tested and are intended solely for the use of the client.*

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2609 North River Road, Port Allen, Louisiana 70767
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ARS Sample Delivery Group: ARS1-14-03569
Client Sample ID: FS-03-B03 BIAS
Sample Collection Date: 12/17/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: NA
ARS Sample ID: ARS1-14-03569-003
Date Received: 12/19/14
Report Date: 01/20/15

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
AC-228	1.970	0.321	0.269	0.135		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA
K-40	5.737	1.360	1.110	0.555		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA
BI-212	0.652	0.637	1.030	0.515	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA
PB-212	1.983	0.269	0.206	0.103		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA
BI-214	1.735	0.289	0.243	0.122		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA
PB-214	2.387	0.357	0.217	0.109		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA
RA-226	4.367	1.921	2.220	1.110		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA
RA-228	1.970	0.321	0.269	0.135		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA
TH-232	1.970	0.321	0.269	0.135		pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA
U-235	0.352	0.397	0.653	0.327	U	pCi/g	ARS-007/EPA 901.1M	01/12/15 12:09	WJS	NA

NOTES:

Project Manager Review

LELAP Certificate# 01949

Analytical Batch	ARS1-B15-00130
SDG	ARS1-14-03569
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-025
Report Units	pCi/g

QC Results per Analytical Batch

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date	01/12/15 11:28	Analysis Technician	WJS

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B15-00130-01	LCS	AM-241	21900	1600	22748	96	590
ARS1-B15-00130-01	LCS	CO-60	40200	1600	42793	94	420
ARS1-B15-00130-01	LCS	CS-137	35900	1600	35450	101	300

Duplicate RER/DER/RPD

Analysis Date	01/12/15 11:42	Analysis Technician	WJS

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	21890	1642	21950	1820	0.02	0.05	0.3
CO-60	40240	1583	42240	1663	0.61	1.70	4.8
CS-137	35930	1563	36640	1608	0.22	0.62	2.0

Method Blank

Analysis Date	01/12/15 11:59	Analysis Technician	WJS

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B15-00130-03	MBL	AM-241	7	17	22	U
ARS1-B15-00130-03	MBL	CO-60	0.0	2.5	23	U
ARS1-B15-00130-03	MBL	CS-137	0.0	2.4	14	U

LELAP Certificate# 01949

ARS INTERNATIONAL
2609 North River Road • Port Allen, Louisiana 70767
1 (800) 401-4277 • Fax (225) 381-2996

Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.

2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.

3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).

4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.

5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.

6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).

7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).

8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).

9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).

10.0) Gamma spectroscopy results are calculated values based on the **ORTEC**® GammaVision ENV32 Analysis Engine.

11.0) ACLASS DOD and ISO 17025 certification applies only to the following analytes and methods: Gross Alpha and Gross Beta (EPA 900, SM7110B&C, SW846 9310); Radium 226 (EPA 903, EPA 903.1, SM 7500 Ra-B, SW846 9315); Radium 228 (EPA 904, SM 7500 Ra-B SW846 9320); Iodine-131(EPA 901.1); Uranium by ICPMS (EPA 200.8); Strontium 89/90 (EPA 905, Eichrom SRW01, HASL 300 Sr-03-RC); Tritium (EPA 906, EPA 906M); Gamma Emitters (EPA 901.1, SM7120B, HASL 300 Ga-01-R); Americium-241, Curium 242/244, Plutonium 239/240 and 241, Thorium 228/230/232, Uranium 234/233 and 238 (Eichrom ACW03 VBS); Lead 210 (HASL 300 Pb-01-RC, Eichrom OTW01); Polonium 210 (HASL 300 Po-01-RC, HASL 300 Po-02-RC); Technetium-99 (Eichrom TCW02, Eichrom TCS01M).

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.

2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.

3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).

4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.

5.0) **HASL 300**

6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detected above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

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ARS INTERNATIONAL
2609 North River Road
Port Allen, LA 70767-3489
PH: (225) 381-2991
FX: (225) 381-2998
www.amrad.com

COC No. _____

Company Name: Perma-Fix Environmental Services
Client Contact : Eric Laning
Address: 2800 Solway Road, Knoxville, TN 37931
Phone #: (865)890-0501
Email: elaning@perma-fix.com
Email: reports to: jhubler@perma-fix.com ; swalnick@perma-fix.com

Purchase Order: _____
Job #: LI Tungsten #144038
Contract #: _____

TWENTY EIGHT (28) DAY TAT

Sent To: ARS International
Project Manager: Project Management
Address: 2609 North River Rd
Port Allen, LA 70767-3489
Phone: (225) 381-2991
Fax: (225) 381-2998
Email: ProjectManagers@amrad.com

Sample No.	Date	Time	Sample Description	# of Containers	Matrix Type*	Gamma Spec Bi-214, Pb-214, Ra-226	Gamma Spec Ac-228, Bi-212, Pb-212, Ra228, Th-232	Gamma Spec U-235, K-40	Iso for Thorium										
01	12-17-14	0950	FS-01-BIAS HOLE	1	S	X	X	X											
02	12-18-14	0715	FS-01-COMP STOCKPILE	1	S	X	X	X											
03	12-17-14	1030	FS-03-B03 BIAS	1	S	X	X	X											
04																			
05																			
06																			
07																			
08																			
09																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			

Method of Shipment: Standard Overnight
Date & Time of Shipment: _____ Courier: FedEx
Air Bill Number: _____

Special Instructions: Assume Equilibrium Ac-228, Th-232, Ra-226
21 day ingrowth

Samplers Name (Print): Frank Quinton
Samplers Signature: _____

	Relinquished by	Date	Time	Received by	Date	Time
Signature	Frank Quinton	12-18-14	0930		12-19-14	1033
Printed Name	Frank Quinton					
Signature						
Printed Name						

* Types of sample: S: solid/soil | L:Liquid | DW: Drinking Water | SW: Surface Water | PW: Produced Water | Sm: Smear | LT: Leak Test | AF: Air Filter | SI: Silica Gel | VG: vegetation | Bly: Bioassay | Sludge

APPENDIX C

Gross Gamma Scans and Sample Locations for Individual Units

Figure C- 1 Final Status Survey Unit 01 Gamma Scan and Sample Locations

Figure C- 2 Final Status Survey Unit 02 Gamma Scan and Sample Locations

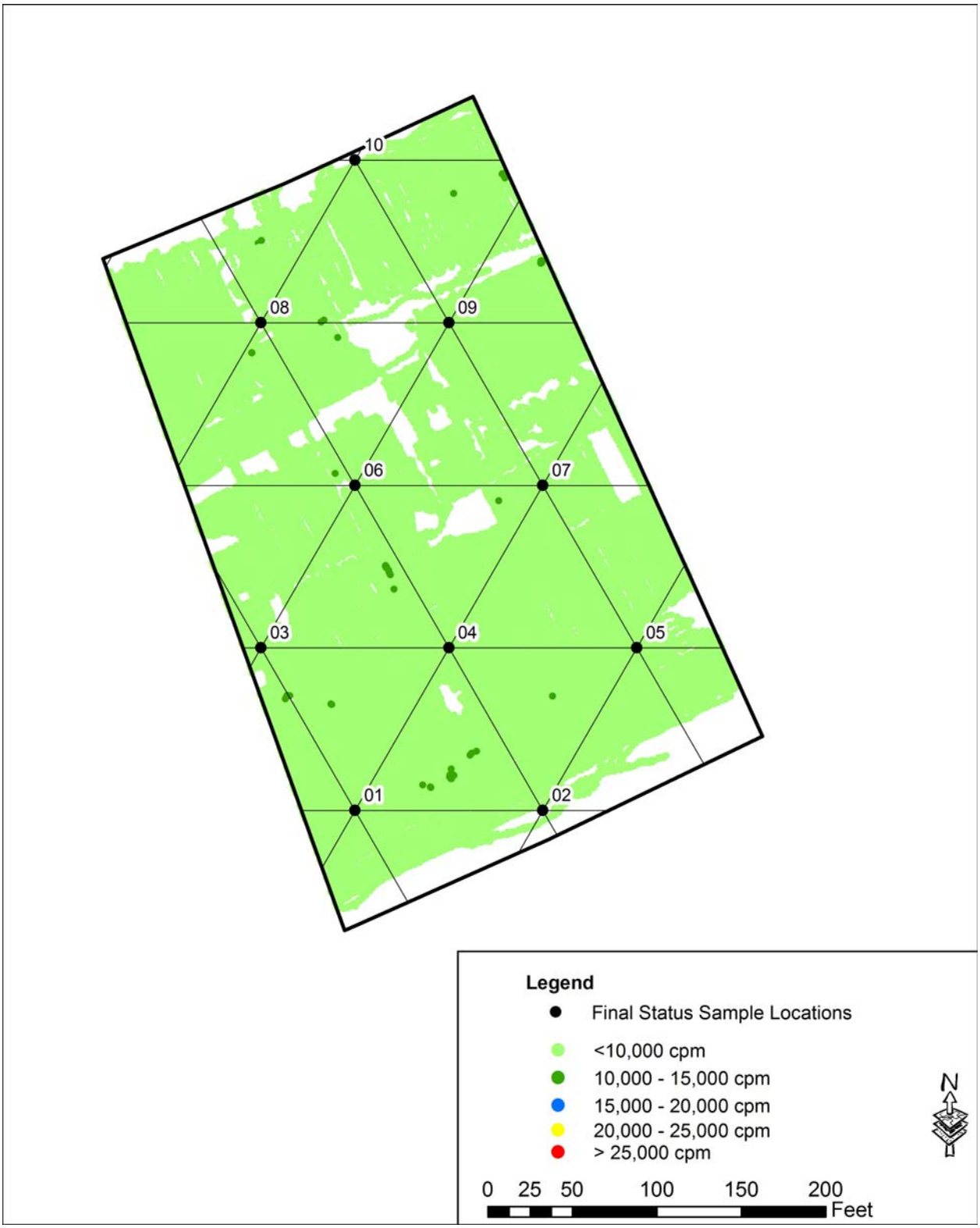


Figure C- 3 Final Status Survey Unit 03 Gamma Scan and Sample Locations

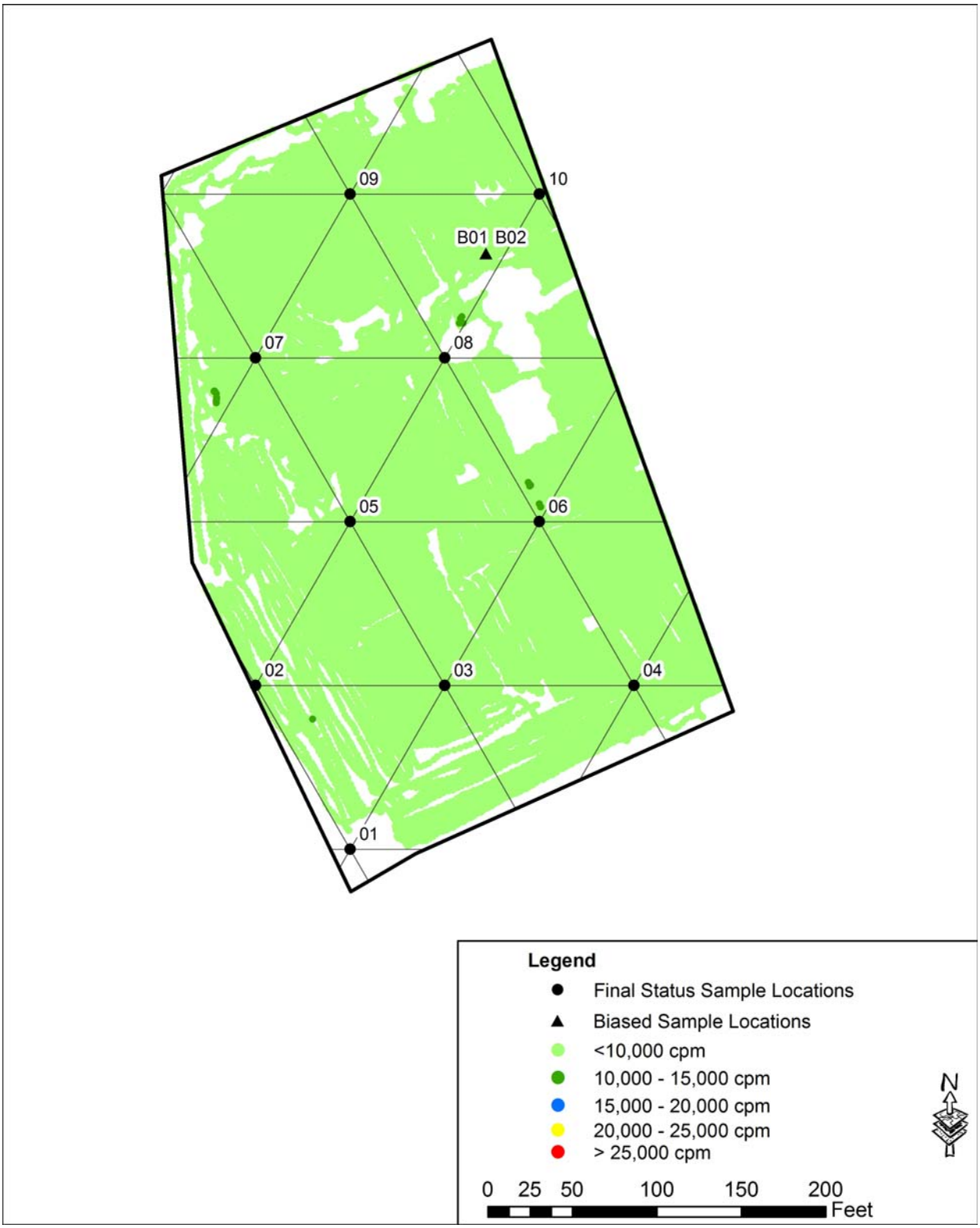


Figure C- 4 Final Status Survey Unit 04 Gamma Scan and Sample Locations

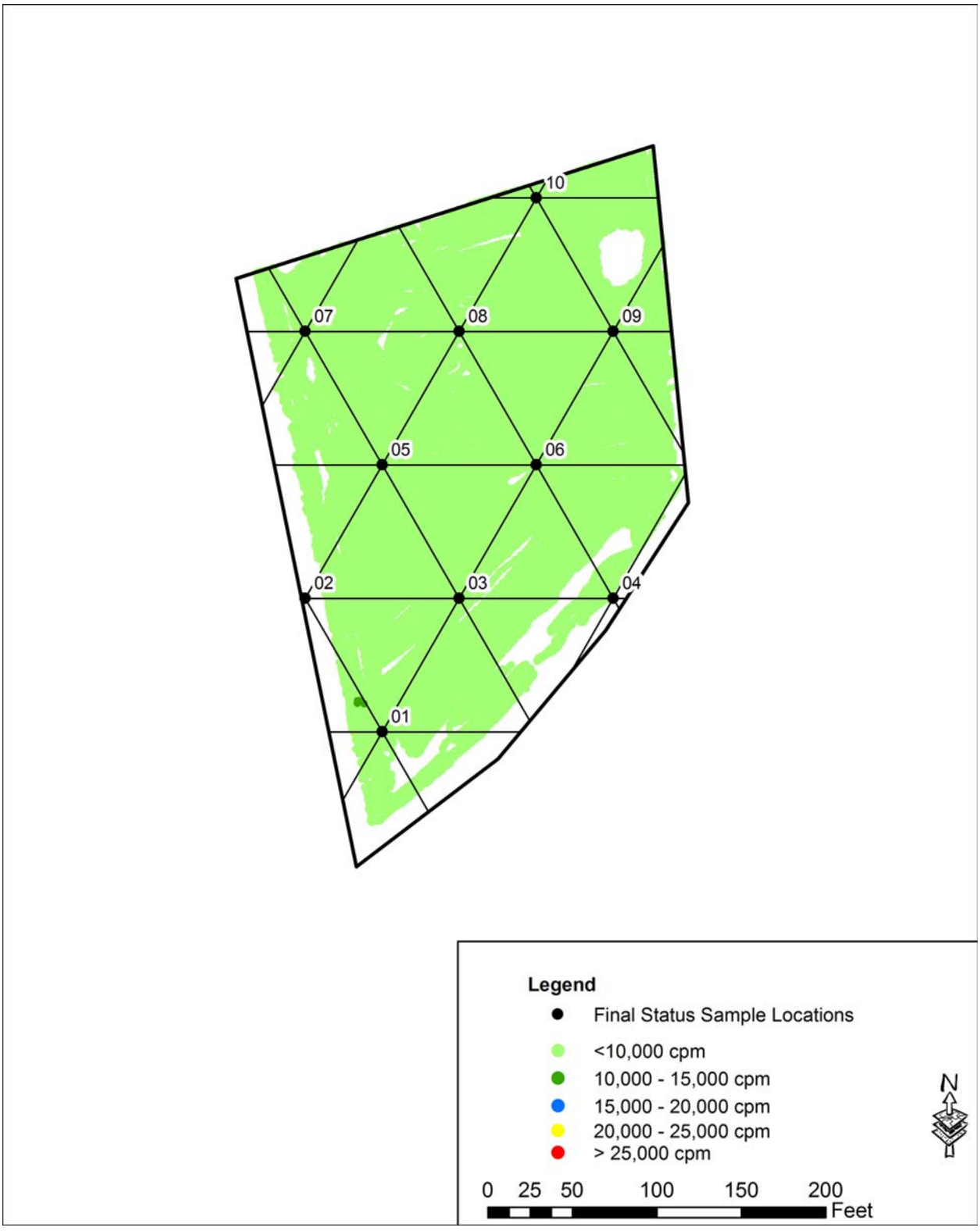


Figure C- 5 Final Status Survey Unit 05 Gamma Scan and Sample Locations

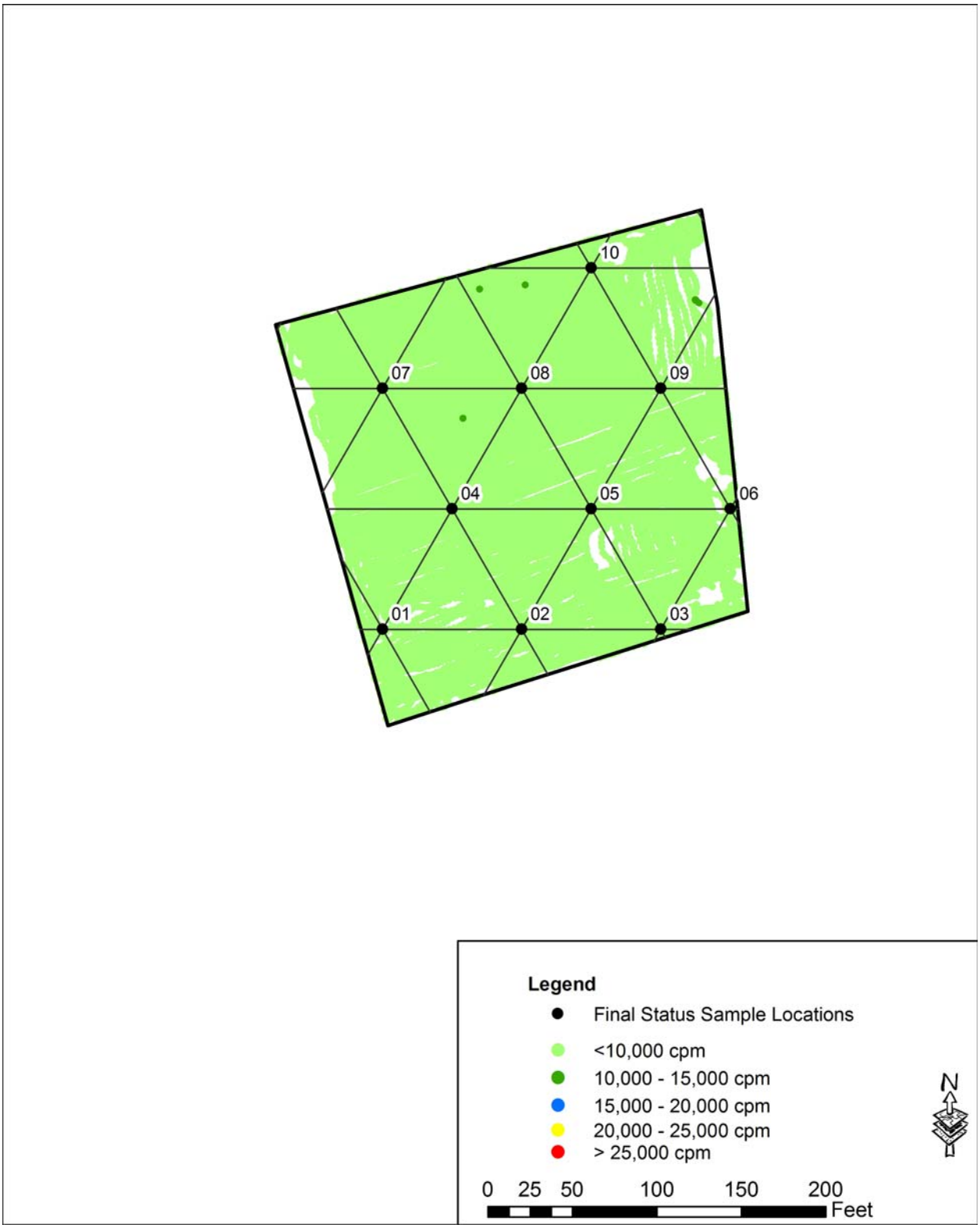
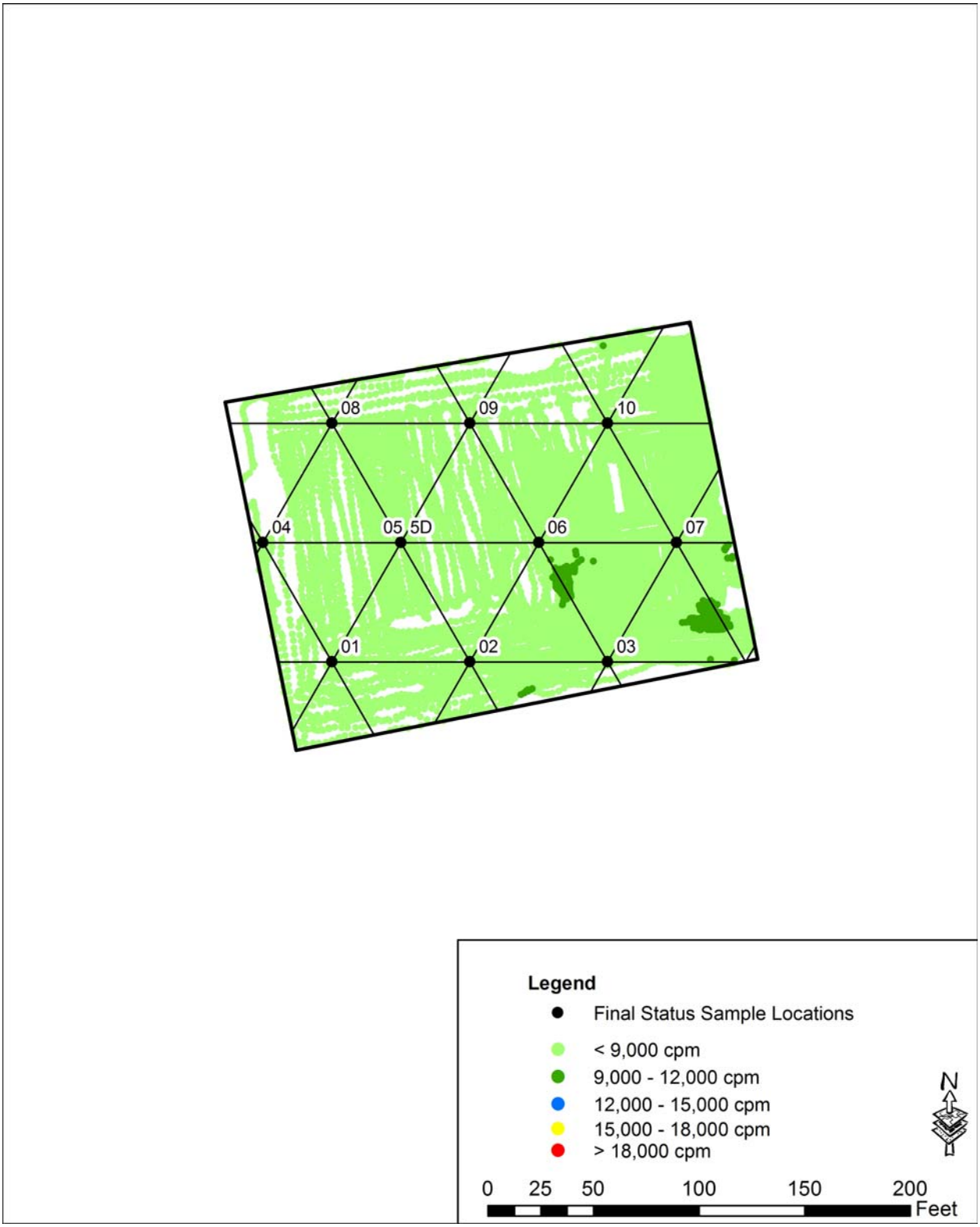


Figure C- 6 Final Status Survey Unit 06 Gamma Scan and Sample Locations



APPENDIX D

Final Status Survey Unit 01 Supplemental Survey and Sample Results

On November 14, 2014, it was determined that excavating to the bottom of the basement of the former East Building was not feasible. Surface water and ground water already impacted an attempt on the north side of the building to reach the subsurface soil below the basement floor. It was concluded by continuing the excavation that a large hole would be created that would fill with water and not allow for FSS activities. A supplemental characterization plan was developed and initiated to fill the data gap under the East Building Pad.

This approach to collect supplemental samples in lieu of gamma scanning is typically performed during MARSSIM surveys when ambient background levels are above scan minimum detectable concentrations (MDCscan). The minimum number of samples per survey unit as calculated in the FSS Plan is 10; therefore a plan was developed to collect 10 additional equally spaced samples on a triangular grid within the footprint of the former building.

The boundary of the supplemental sample area was approximately 1,078 m^2. This resulted in a triangular grid with a line spacing of 11.1 m. Each location was sampled with a direct push (Geoprobe®) machine. The intent was to advance a core sample a minimum of 15 cms through the subsurface slab. Eight of the 10 locations advanced through the subsurface slab. The remaining two locations had no evidence of encountering the pad. The samples layout is presented in **Figure D-1**.

Samples collected during the supplemental characterization were sent to the same offsite radiological laboratory as the other FSS samples and analyzed by the same methods. The results and the locations of the samples are provided in **Table D-1**. Sample location FS-01-S02 had a gross radium result that exceeded 5 pCi/g. Howver, when the average radium background of 1.84 pCi/g was subtracted from the result, the sample location met the clean-up criteria of 5 pCi/g net radium. No other sample within the supplemental sample grid exceeded the established release criteria, so no further statistical analyses were required.

Figure D 1 Supplemental Characterization Sample Locations

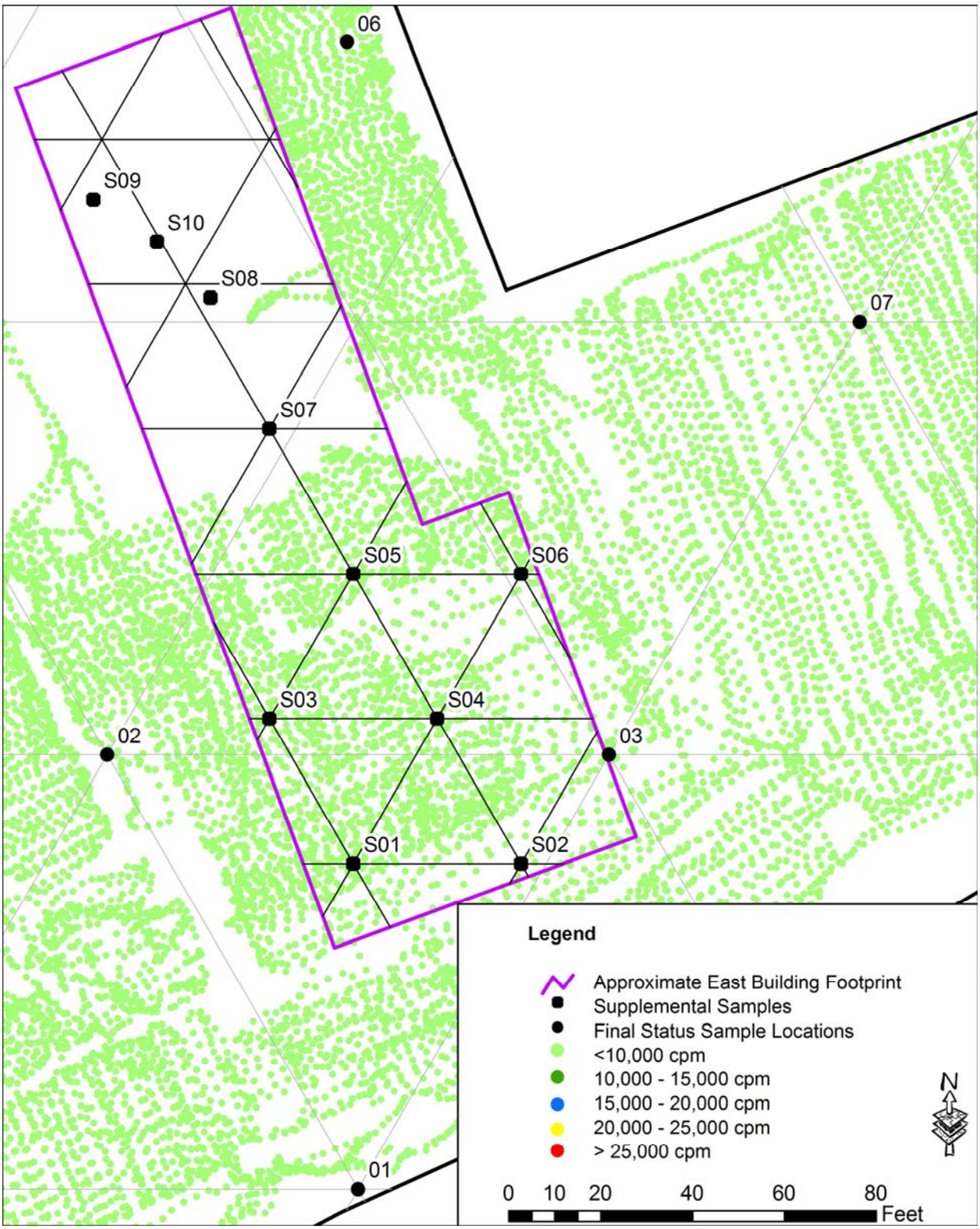


Table D-1 Supplemental Sample Results

Sample ID	Northing	Easting	Ra 226 + Ra 228	Th 230 + Th 232
FS01-S01	253135.52	1084419.03	1.68	1.68
FS01-S02	253135.52	1084455.53	5.25	1.61
FS01-S03	253167.13	1084400.78	1.22	1.22
FS01-S04	253167.13	1084437.28	2.89	2.89
FS01-S05	253198.74	1084419.03	1.64	1.64
FS01-S06	253198.74	1084455.53	2.16	2.16
FS01-S07	253230.35	1084400.78	1.68	1.68
FS01-S08	253258.99	1084387.94	3.19	3.19
FS01-S09	253280.29	1084362.44	1.13	1.13
FS01-S10	253271.20	1084376.29	1.33	1.33
Bold = Systematic Sample		**Mean**	2.22	1.85
		Std Dev	1.27	0.69

APPENDIX E

EPA Exempt Areas

Figure E-1. EPA Exempt Area Sample Locations

Figure E-2 Map of EPA Exempt Area from 2008 RACR

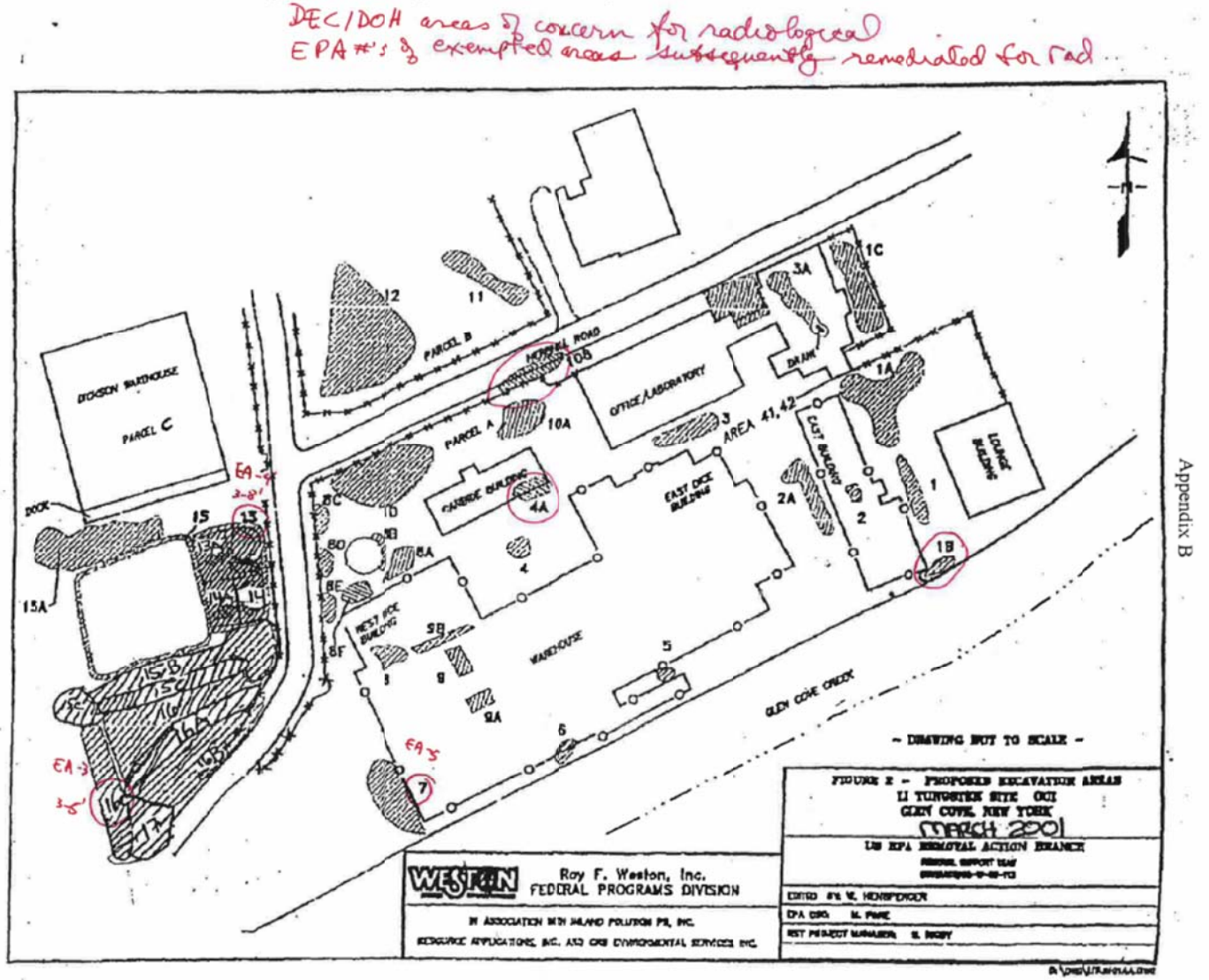


Table E-1. EPA Supplemental Sample Results Summary

Sample ID	Northing	Easting	Depth (ft)	Date	Total Radium	Total Thorium
2095-EA4 0-6	253154.77	1083696.43	0.0-0.5	10/27/14	1.86	1.86
2095-EA4 bias 4	253154.77	1083696.43	3.5-4.0	10/27/14	1.39	1.39
2095-EA4 bottom 8	253154.77	1083696.43	7.5-8.0	10/27/14	2.28	2.28
2096-16 (EA-3) 0-6	252869.84	1083560.64	0.0-0.5	10/27/14	2.59	2.59
2096-16 (EA-3) bias 7	252869.84	1083560.64	6.5-7.0	10/27/14	1.98	1.98
2096-16 (EA-3) bottom 8	252869.84	1083560.64	7.5-8.0	10/27/14	4.76	4.76
2097 0-6	252839.86	1083885.30	0.0-0.5	10/27/14	0.83	0.83
2097 bias 4	252839.86	1083885.30	3.5-4.0	10/27/14	0.28	0.28
2097 bottom 8	252839.86	1083885.30	7.5-8.0	10/27/14	0.71	0.71
2098-4A 0-6	253191.53	1084009.36	0.0-0.5	10/27/14	3.64	3.64
2098-4A bias 2	253191.53	1084009.36	1.5-2.0	10/27/14	1.52	1.52
2098-4A bottom 8	253191.53	1084009.36	7.5-8.0	10/27/14	0.77	0.77
2099-1B 0-6	253139.16	1084526.55	0.0-0.5	10/27/14	1.77	1.71
2099-1B bias 5	253139.16	1084526.55	4.5-5.0	10/27/14	1.67	1.67
2099-1B bottom 8	253139.16	1084526.55	7.5-8.0	10/27/14	2.61	2.61
2100-10B 0-6	253332.88	1084040.28	0.0-0.5	10/27/14	3.53	1.66
2100-10B bias 6	253332.88	1084040.28	5.5-6.0	10/27/14	3.14	3.14
2100-10B bottom 8	253332.88	1084040.28	7.5-8.0	10/27/14	2.69	2.69